

The Road from **Exploration** to **Explanation**, and Back

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@AlyssaAGoodman

Traditionally, travel from exploration to explanation is called
“Scholarly Publishing” if its *dry*, and “Public Outreach,” if it’s *beautiful*.

Explore



Explain

Explore



Explain

It's much harder to go the other way.

Explore

And, the *best* roads are two-way.

Explain



VIENNA



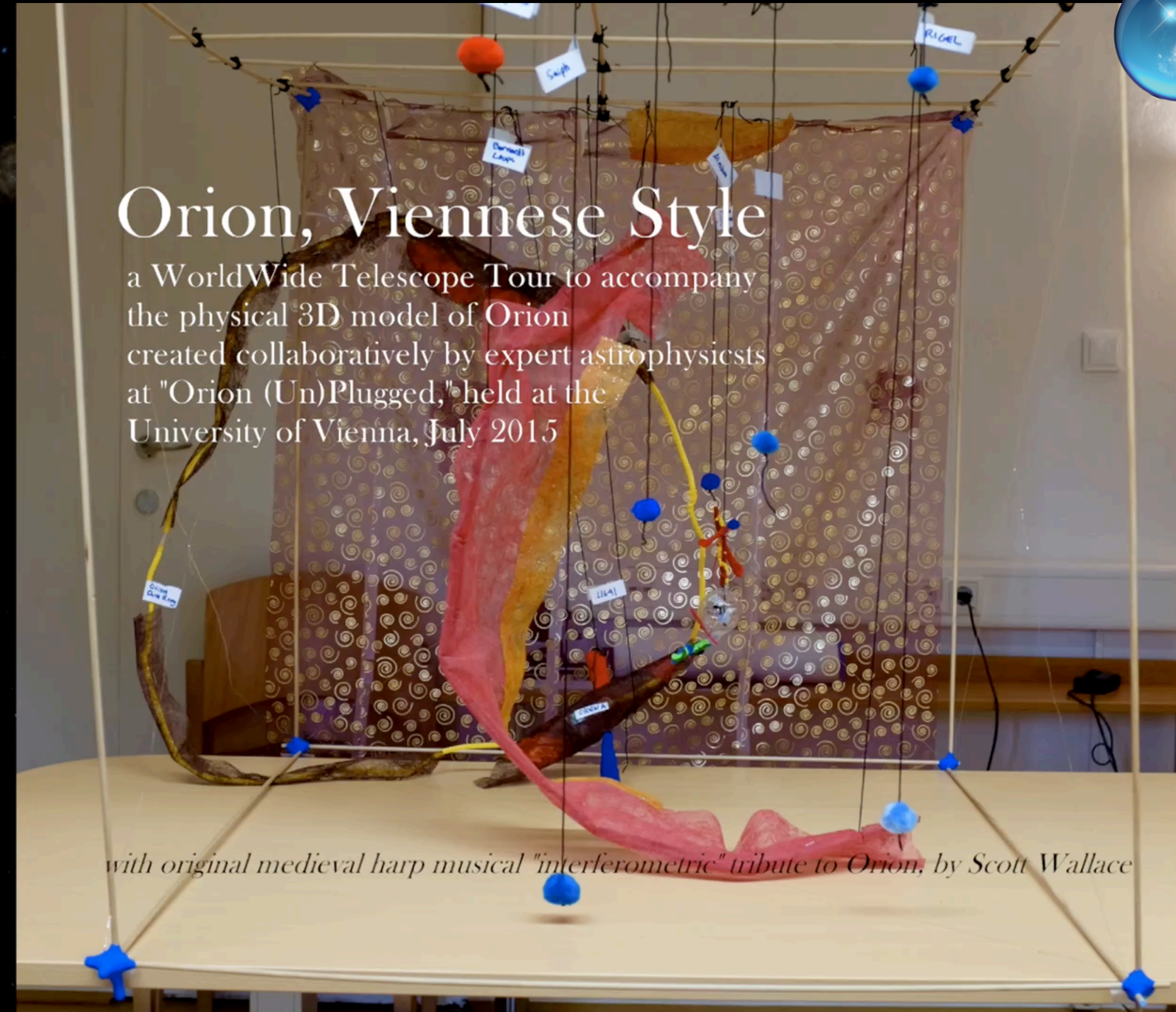
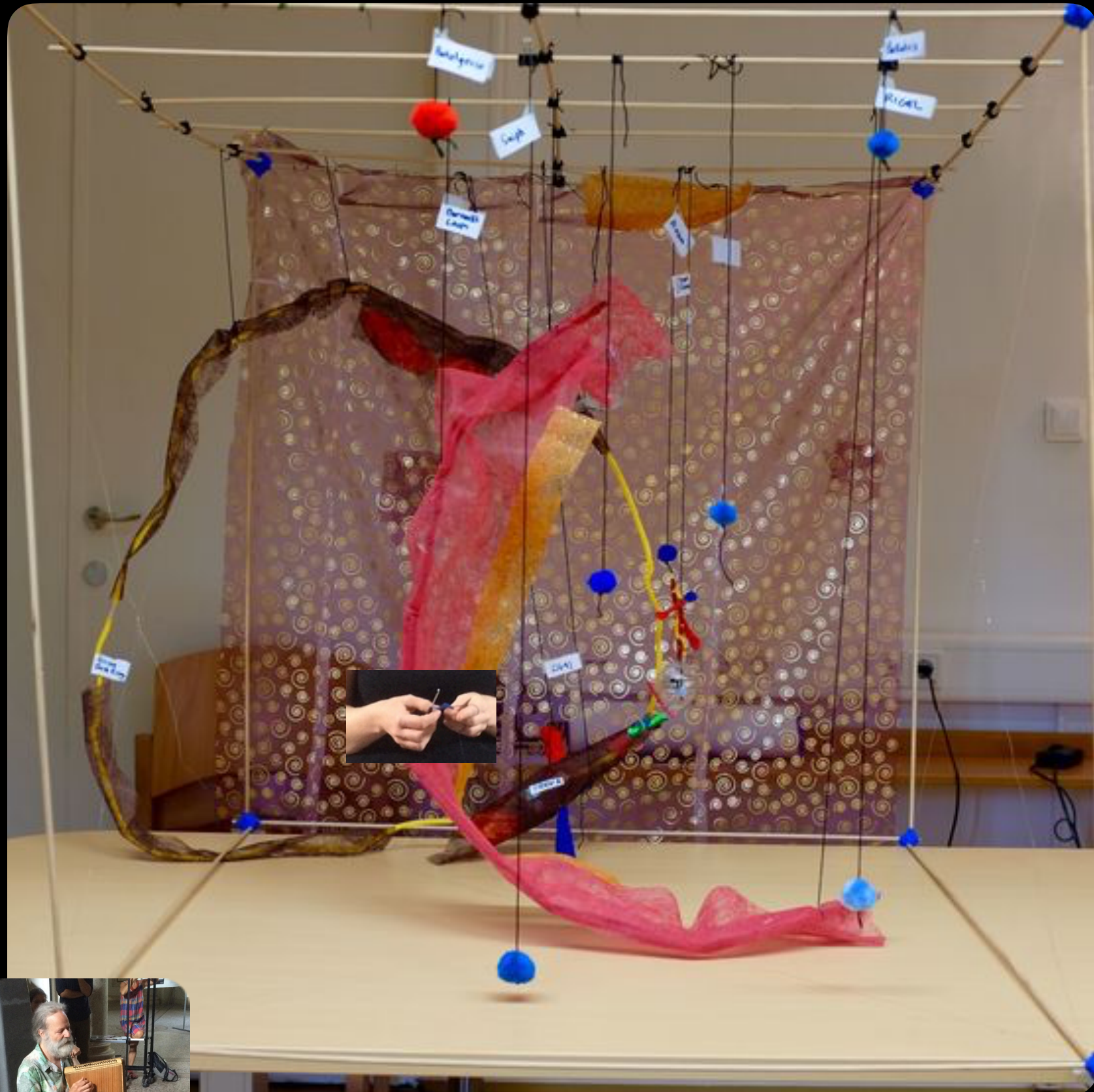
Structure Identification

Human | ✓ | ✓ | ✓ | ⊙ | ✗ | ✓ | ✓ | ✓ | ✓

Available	human Point Sources	Vel. Cch Start	Fibers	Filaments	Ngpa shape Unbiased	Hier-archical	Clumps + Blobs	Bubbles	Outflow
X F.VEB (on fits)		✓	✓	✓	✓	(v)			
✓ Dendrograms on p-v cubes or p-p map		(v)	if enough reconstruct	✓ not too long	(v)	4	✓	meh	meh
✓ CLUMPFIND	✓	(v)	x	x	(v)	11	✓	x	x
✓ Disperse	x	(v)	✓	✓?	x x	x	x	if high contrast	x?
X Getsources	✓	x	x	✓	x	x	✓	x	x
✓ Followup	✓	✓	x	x	(v)	x	✓	x	x
SCIMES									

same as dendro but → yay!

VIENNA



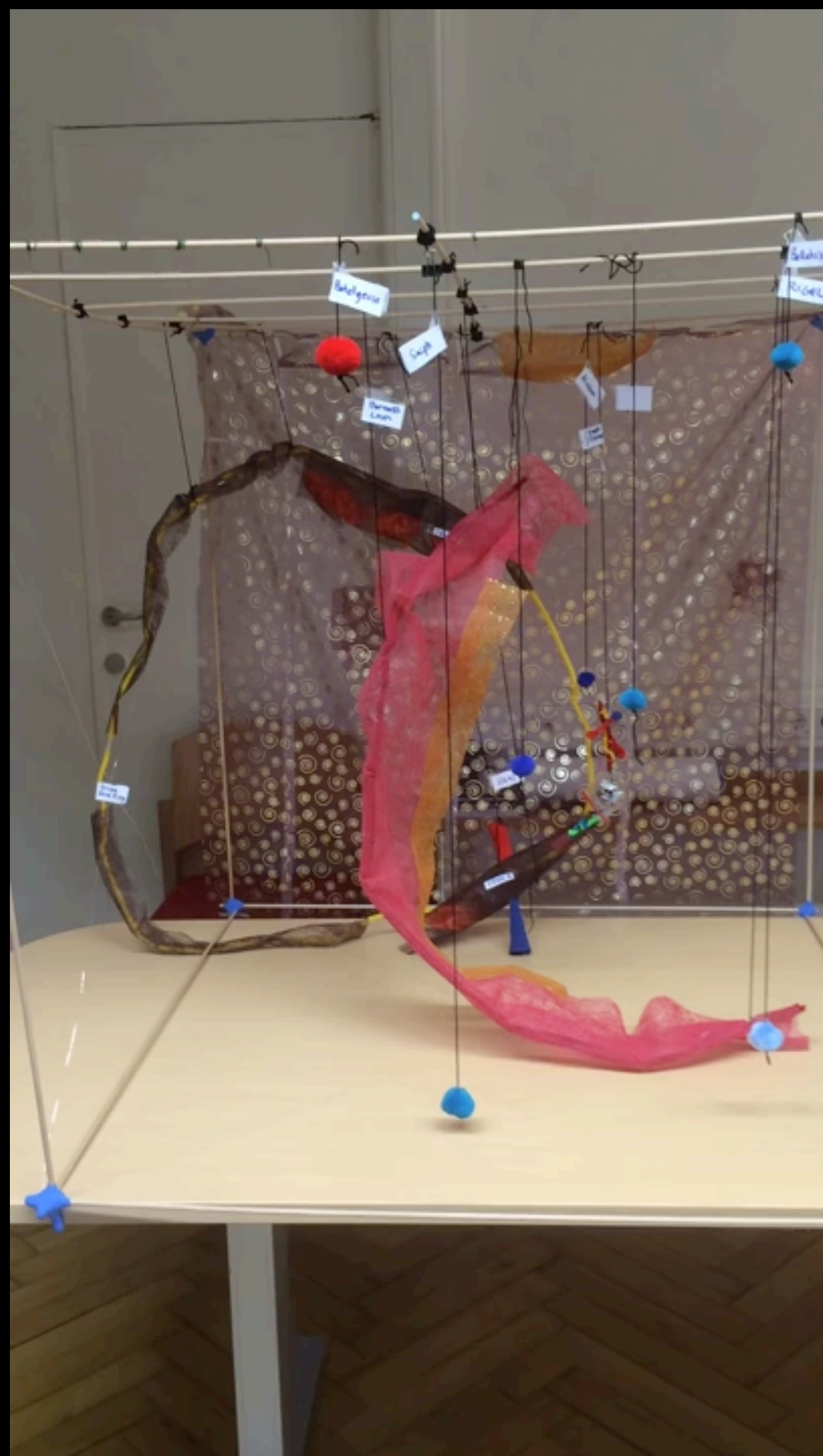
Orion, Viennese Style

a WorldWide Telescope Tour to accompany the physical 3D model of Orion created collaboratively by expert astrophysicists at "Orion (Un)Plugged," held at the University of Vienna, July 2015

with original medieval harp musical "interferometric" tribute to Orion, by Scott Wallace



VIENNA



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**Astronomy
&
Astrophysics**

VISION – Vienna survey in Orion

I. VISTA Orion A Survey^{*,**}

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ABSTRACT

Context. Orion A hosts the nearest massive star factory, thus offering a unique opportunity to resolve the processes connected with the formation of both low- and high-mass stars. Here we present the most detailed and sensitive near-infrared (NIR) observations of the entire molecular cloud to date.

Aims. With the unique combination of high image quality, survey coverage, and sensitivity, our NIR survey of Orion A aims at establishing a solid empirical foundation for further studies of this important cloud. In this first paper we present the observations, data reduction, and source catalog generation. To demonstrate the data quality, we present a first application of our catalog to estimate the number of stars currently forming inside Orion A and to verify the existence of a more evolved young foreground population.

Methods. We used the European Southern Observatory's (ESO) Visible and Infrared Survey Telescope for Astronomy (VISTA) to survey the entire Orion A molecular cloud in the NIR J , H , and K_S bands, covering a total of ~ 18.3 deg². We implemented all data reduction recipes independently of the ESO pipeline. Estimates of the young populations toward Orion A are derived via the K_S -band luminosity function.

Results. Our catalog (799 995 sources) increases the source counts compared to the Two Micron All Sky Survey by about an order of magnitude. The 90% completeness limits are 20.4, 19.9, and 19.0 mag in J , H , and K_S , respectively. The reduced images have 20% better resolution on average compared to pipeline products. We find between 2300 and 3000 embedded objects in Orion A and confirm that there is an extended foreground population above the Galactic field, in agreement with previous work.

THE REAL WORLD

New Ideas
Discoveries

Public Outreach
Scholarly Publishing

Explore

Explain

“It’s much harder to go the other way.”

Astronomy Picture of the Day

[Discover the cosmos!](#) Each day a different image or photograph of our fascinating universe is featured, along with a brief explanation written by a professional astronomer.

2018 March 11



Public Outreach

Duel Particle Beams in Herbig-Haro 24

Image Credit: [NASA](#), [ESA](#), [Hubble Heritage \(STScI/AURA\)](#)/Hubble-Europe Collaboration;
Acknowledgment: D. Padgett ([NASA's GSFC](#)), T. Megeath (U. Toledo), B. Reipurth (U. Hawaii)

Explanation: [This might look like](#) a double-bladed lightsaber, but these two cosmic jets actually beam outward from [a newborn star in a galaxy near you](#). Constructed from Hubble Space Telescope image data, the stunning scene spans about half a light-year across Herbig-Haro 24 (HH 24), some 1,300 light-years away in the [stellar nurseries](#) of the Orion B molecular cloud complex. Hidden from direct view, [HH 24's](#) central protostar is surrounded by cold dust and gas flattened into a rotating [accretion disk](#). As material from the disk falls toward the young stellar object it heats up. Opposing [jets are blasted out](#) along the system's rotation axis. Cutting through the region's interstellar matter, the narrow, energetic jets produce a series of glowing shock fronts [along their path](#).

March 11, 2018 Astronomy Picture of the Day

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[Discover the cosmos!](#) Each day a different image or photograph of our fascinating universe is featured, along with a brief explanation written by a professional astronomer.

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Duel Particle Beams in Herbig-Haro 24

Image Credit: [NASA](#), [ESA](#), [Hubble Heritage \(STScI/AURA\)](#)/Hubble-Europe Collaboration;
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Herbig-Haro Jet HH 24



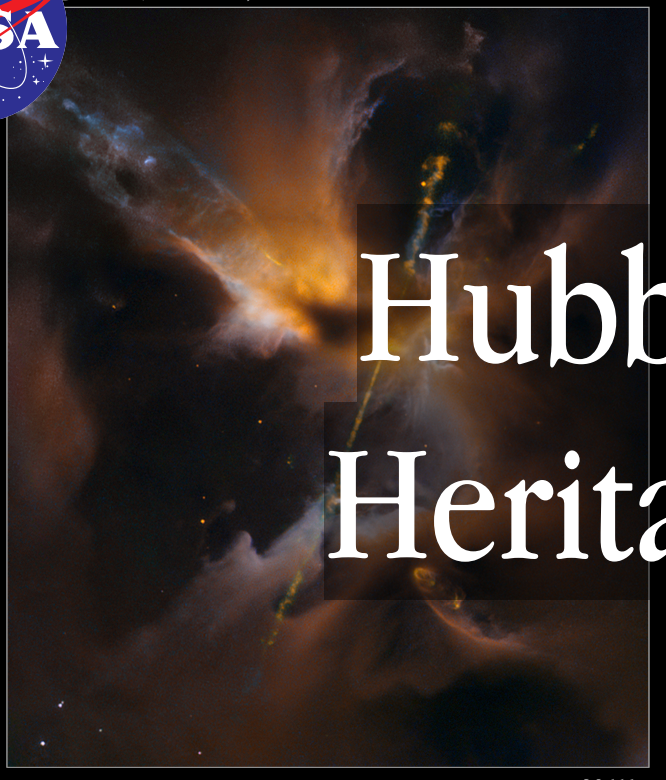
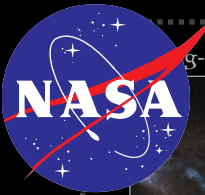
Hubble
Heritage

NASA and ESA • Hubble Space Telescope • WFC3/IR • WFPC2 • STScI-PRC15-42a

March 11, 2018 Astronomy Picture of the Day

2015 Hubble Heritage Press Release

Explain



Herbig-Haro Jet HH 24

Hubble Heritage

About this Object

Object Name: Herbig-Haro 24, HH 24
Description: Herbig-Haro Jet
Position: RA: 05h 46m 09.12s (J2000.0); Dec: -00° 10' 12.00"
Constellation: Orion
Distance: 1,350 light-years (414 parsecs)

About the Data

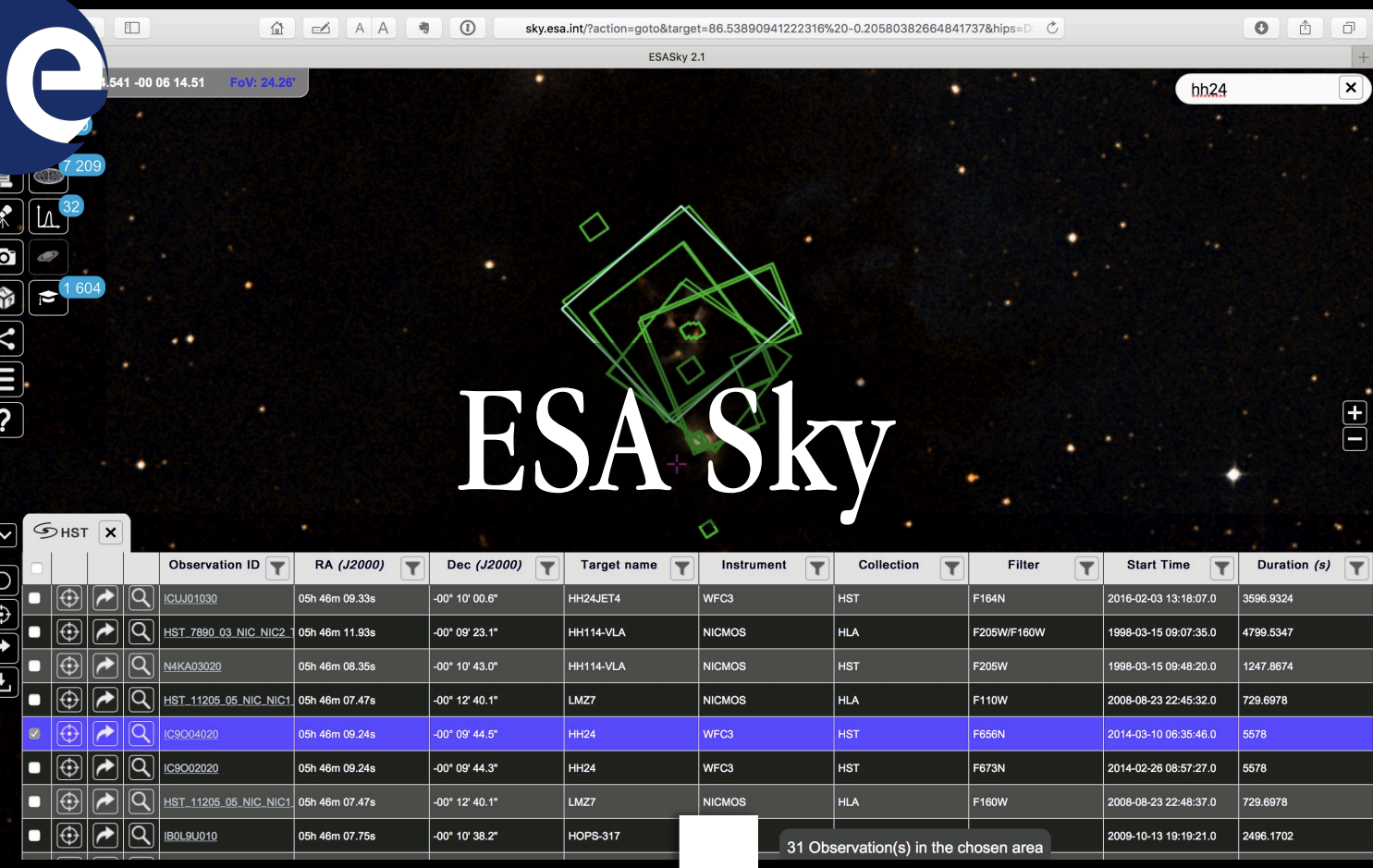

Prep.	Principal Investigator	Instrument	Filter	Exposure Date
1960	D. Pridgett (OSG) et al.	WFPC2	F814W (J)	August 4, 2001
1348	T. Weaver (U. Hawaii) et al.	WFC3/IR	F160W (J)	October 13, 2009
1348	S. Reipurth (U. Hawaii) et al.	WFC3/IR	F164W (Fz II)	February 18, 2014

About this Image

This image is a composite of separate exposures acquired by the WFC3 and WFC3/IR instruments. Several filters were used to sample various wavelengths. The color results from assigning different hues (colors) to each monochromatic (grayscale) image associated with an individual filter. In this case, the assigned colors are:

Filter	Color
F814W (J)	Blue
F814W (J) + F160W (J)	Green
F160W (J)	Orange
F164W (Fz II)	Red

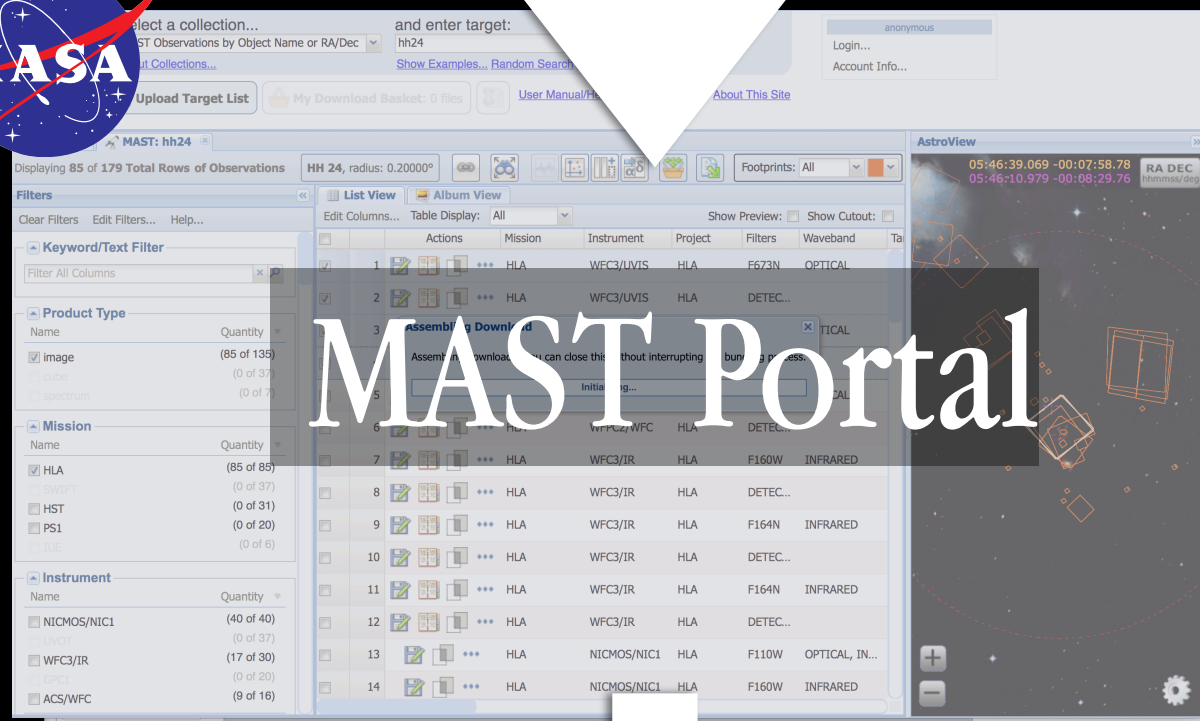

Orientation/Scale: HH 24, Hubble Space Telescope, WFC3/IR, WFC3/IR



ESA Sky

Observation ID	RA (J2000)	Dec (J2000)	Target name	Instrument	Collection	Filter	Start Time	Duration (s)
ICUJ01030	09h 46m 09.33s	-00° 10' 00.6"	HH24JET4	WFC3	HST	F164N	2016-02-03 13:18:07.0	3596.8324
HST_7890_03_NIC_NICA	09h 46m 11.95s	-00° 09' 23.1"	HH114-VLA	NICMOS	HLA	F209W/F160W	1998-03-15 09:07:35.0	4790.5347
NHSA03020	09h 46m 08.35s	-00° 10' 43.0"	HH114-VLA	NICMOS	HST	F209W	1998-03-15 09:48:20.0	1247.8674
HST_11206_05_NIC_NICI	09h 46m 07.47s	-00° 12' 40.1"	LMZ7	NICMOS	HLA	F110W	2008-08-23 22:45:32.0	729.6976
IC9000020	09h 46m 09.24s	-00° 09' 44.6"	HH24	WFC3	HST	F668N	2014-02-26 08:57:27.0	6578
IC9000020	09h 46m 09.24s	-00° 09' 44.3"	HH24	WFC3	HST	F673N	2014-02-26 08:57:27.0	6578
HST_11206_05_NIC_NICI	09h 46m 07.47s	-00° 12' 40.1"	LMZ7	NICMOS	HLA	F160W	2008-08-23 22:48:37.0	729.6976
B0LBU010	09h 46m 07.75s	-00° 10' 38.2"	HOPB317				2009-10-13 19:19:21.0	2496.1702

31 Observation(s) in the chosen area

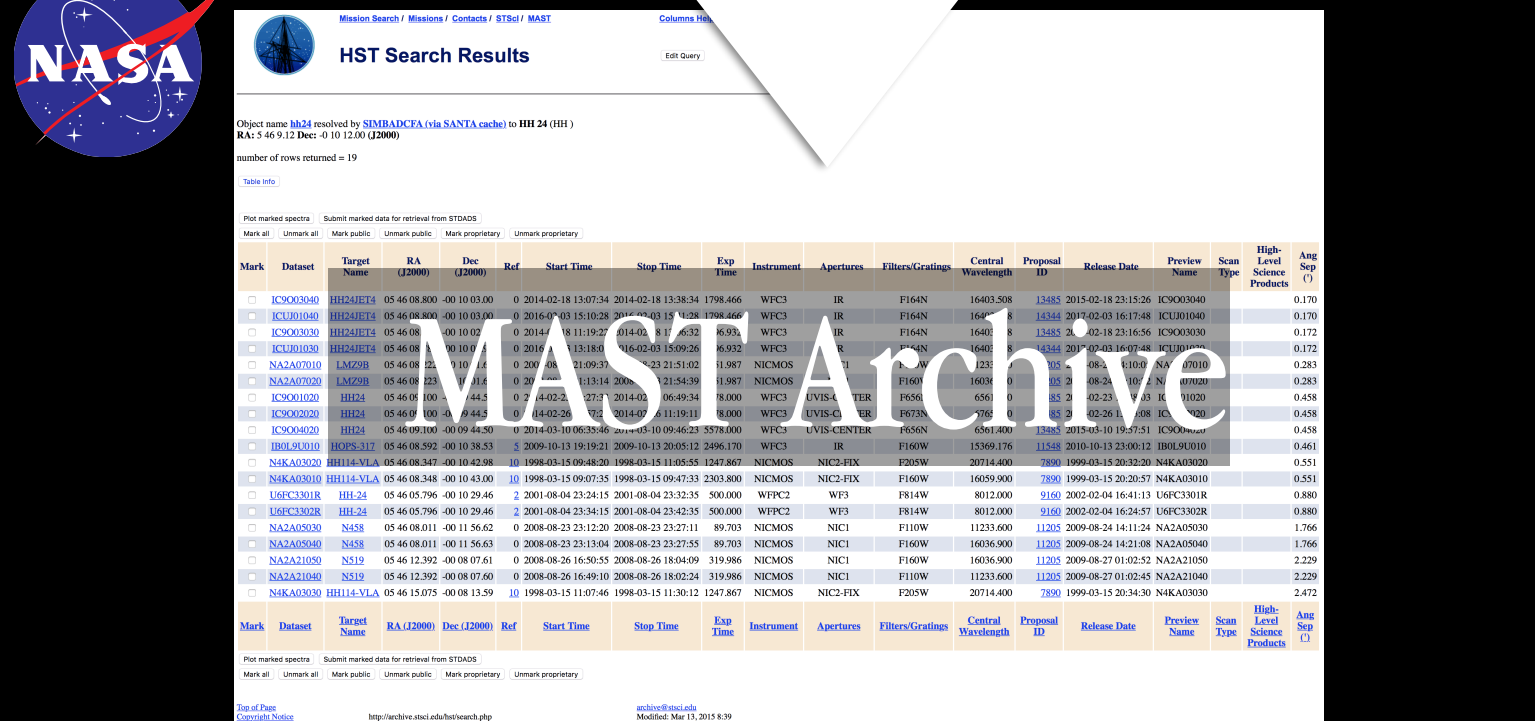
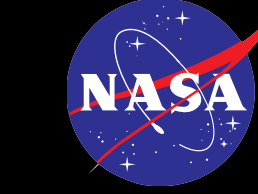


MAST Portal

Filter by: Keyword/Text Filter

Product Type	Name	Quantity
Image	Image	(85 of 139)
Mission	Mission	(85 of 85)
Instrument	Instrument	(40 of 40)

Product Type	Name	Quantity
Image	Image	(85 of 139)
Mission	Mission	(85 of 85)
Instrument	Instrument	(40 of 40)

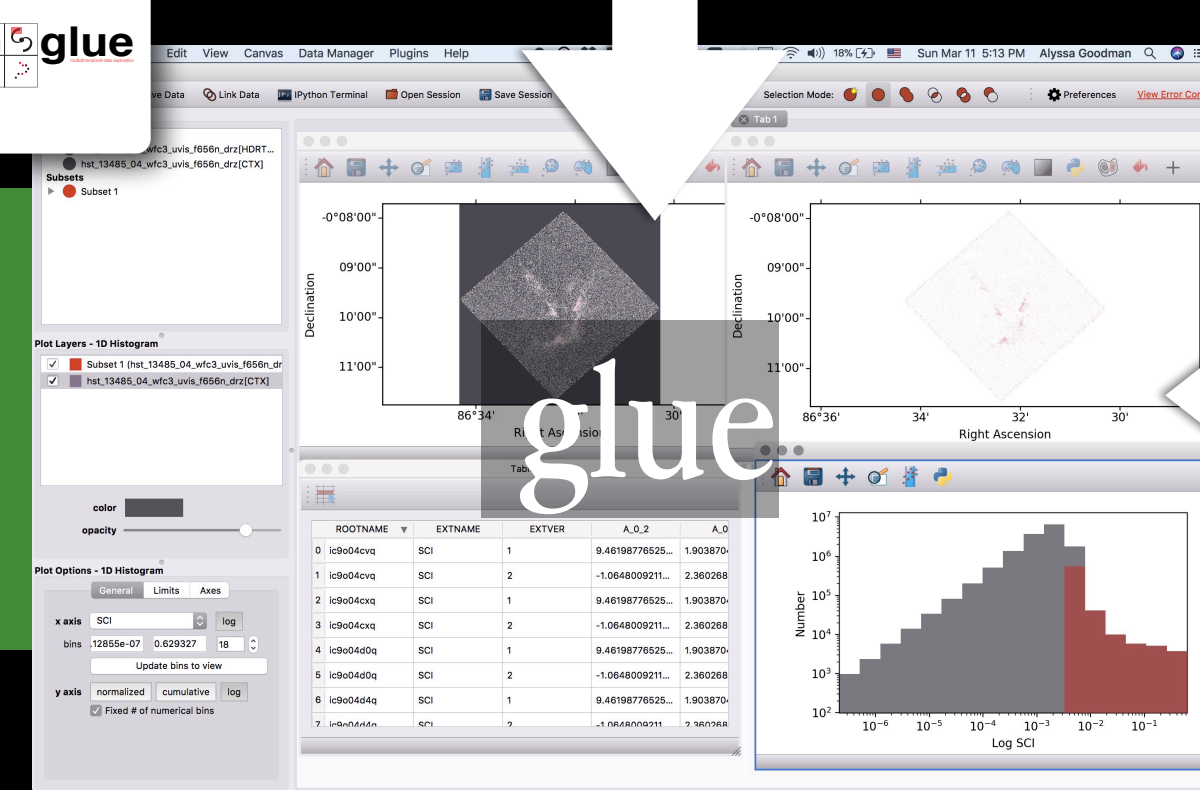



HST Search Results

Original name: HH24 resolved by NICMOS/ICA on SASTA under to HH 24 (HH1)

Mark	Dataset	Target Name	RA (J2000)	Dec (J2000)	Ref	Start Time	Stop Time	Exp Time	Instrument	Aperture	Filter/Cutout	Central Wavelength	Proposal ID	Release Date	Previous Name	Scan Type	High Level Science Products	Avg Sep (CT)
1	IC9000040	HH24JET4	05 46 09.33	-00 10 00.6	0	2016-02-03 13:18:07.0	2016-02-03 13:18:07.0	3596.8324	WFC3	IR	F164N	1640.0	13485	2016-02-03 13:18:07.0	IC9000040	IR	High Level Science Products	0.170
2	IC9000030	HH24JET4	05 46 09.33	-00 10 00.6	0	2016-02-03 13:18:07.0	2016-02-03 13:18:07.0	3596.8324	WFC3	IR	F164N	1640.0	13485	2016-02-03 13:18:07.0	IC9000030	IR	High Level Science Products	0.170
3	IC9000020	HH24JET4	05 46 09.33	-00 10 00.6	0	2016-02-03 13:18:07.0	2016-02-03 13:18:07.0	3596.8324	WFC3	IR	F164N	1640.0	13485	2016-02-03 13:18:07.0	IC9000020	IR	High Level Science Products	0.170

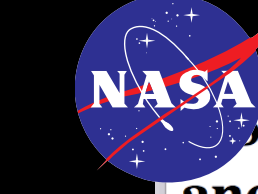
Explore



glueviz

Plot Options - 1D Histogram

ROOTNAME	EXTNAME	EXTVER	A_0.2	A_0
ic9000040	SCI	1	9.46198778922L	1.903870
ic9000030	SCI	2	-1.06480092921L	2.360208
ic9000020	SCI	1	9.46198778922L	1.903870
ic9000010	SCI	2	-1.06480092921L	2.360208
ic9000000	SCI	1	9.46198778922L	1.903870
ic9000000	SCI	2	-1.06480092921L	2.360208
ic9000000	SCI	1	9.46198778922L	1.903870
ic9000000	SCI	2	-1.06480092921L	2.360208



HST Retrieval Submission Success:

anonymous98615

[Archive Status](#)

Success! Your HST Request ID: anonymous98615

The following datasets will be retrieved:

icuj01030,

email! ftp!

You will shortly receive an email indicating that your request has been accepted, and another when it is completed.

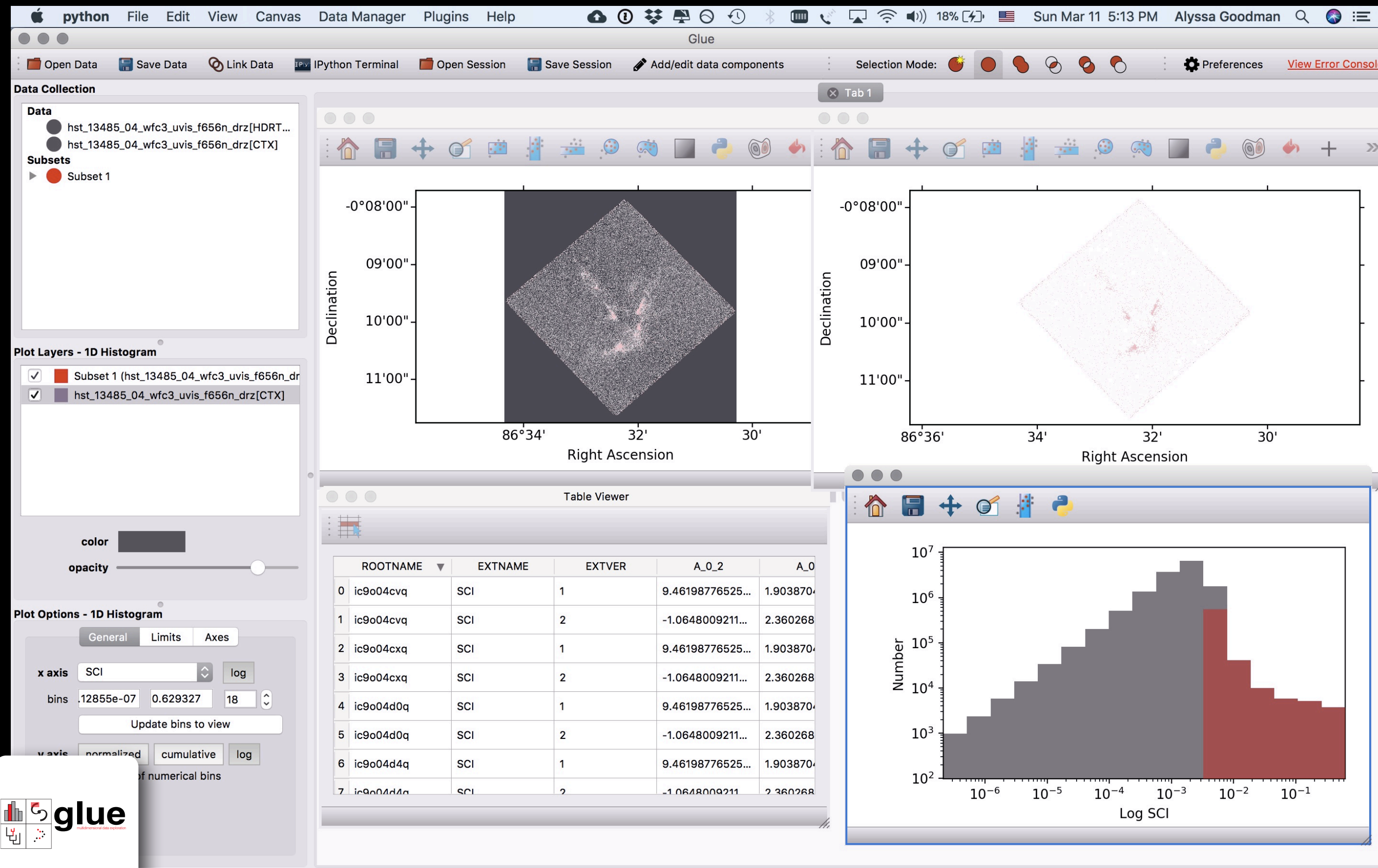
Sun Mar 11 16:07:52 2018
archive@stsci.edu

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Explore

Explain

A 5 minute journey, if you know the way.

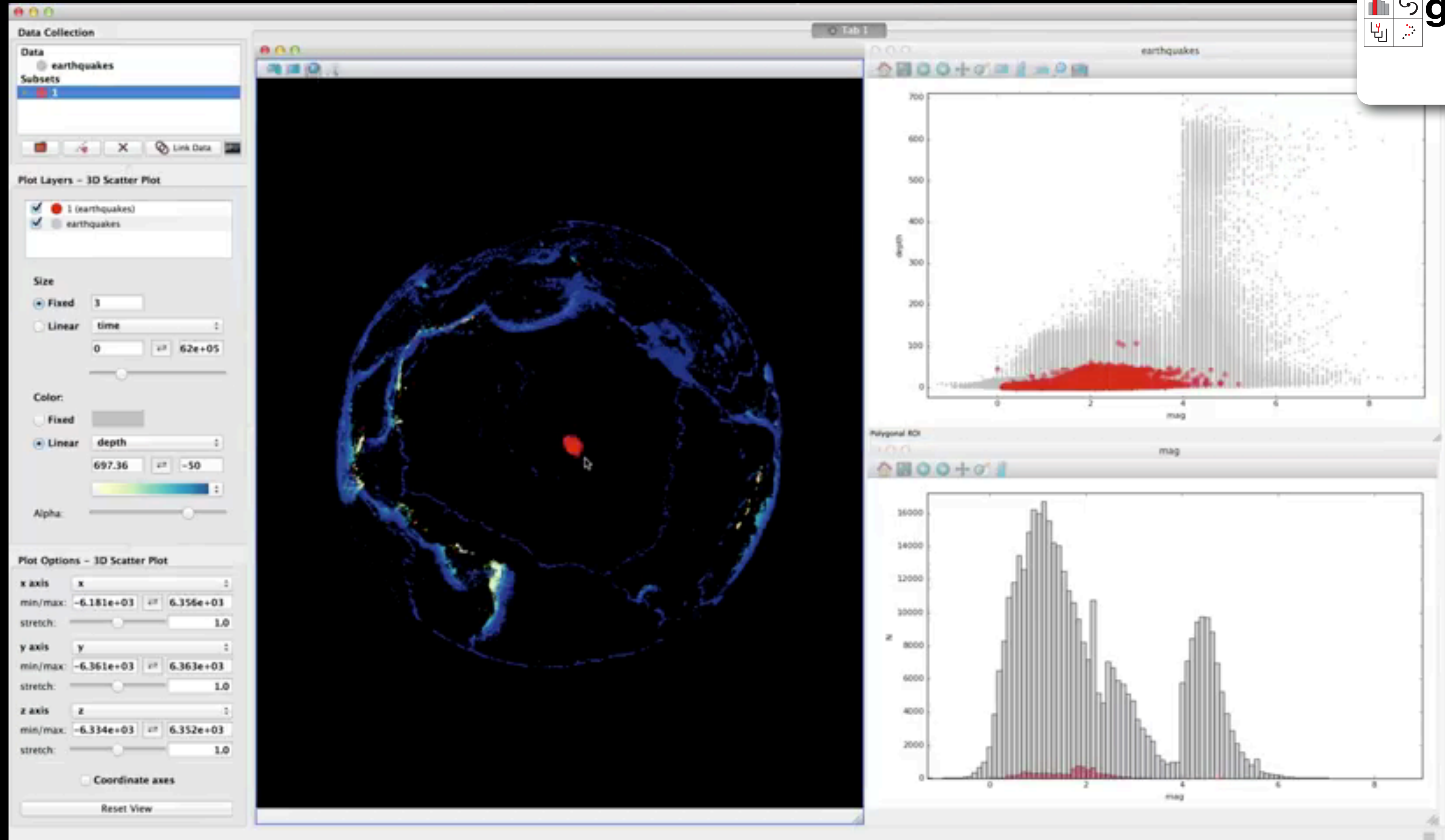


Herbig-Haro Jet HH 24



Hubble
Heritage

“Linked Views of High-dimensional Data” (in Python)



Explore



Explain

glueing together the Milky Way

The screenshot displays the Glueviz software interface, which is used for visualizing and analyzing multi-source astronomical data. The interface is divided into several panels:

- Data Collection:** A sidebar on the left lists data sources under "Data" (HOPS_ammonia_catalog_ICRS, Nessie_13CO_ThrUMMS_slab, Nessie_GLIMPSE_8micron_cropped, Nessie_HIGAL_Column_Density[PRIMA...]) and "Subsets" (Nessie, and four specific Nessie subsets).
- 2D Image:** A central plot showing Galactic Latitude (0°00' to 45') vs. Galactic Longitude (340°00' to 337°30'). A horizontal band of purple points is highlighted.
- WorldWideTelescope (WWT):** A lower plot showing Galactic Latitude (0°00' to -1°00') vs. Galactic Longitude. A red outline highlights a region of interest.
- WorldWideTelescope (WWT) Plot Options:** A panel below the WWT plot with settings for "Foreground" (IRIS: Improved Reprocessing), "Opacity", "Background" (Digitized Sky Survey (Color)), and a checked "Galactic Plane mode".
- Histogram:** A plot on the right showing a distribution of values with a vertical orange line indicating a peak.
- Galaxy Image:** A 3D visualization of the Milky Way galaxy with a yellow dot marking a specific location.

The "glue" logo is visible in the bottom left corner.

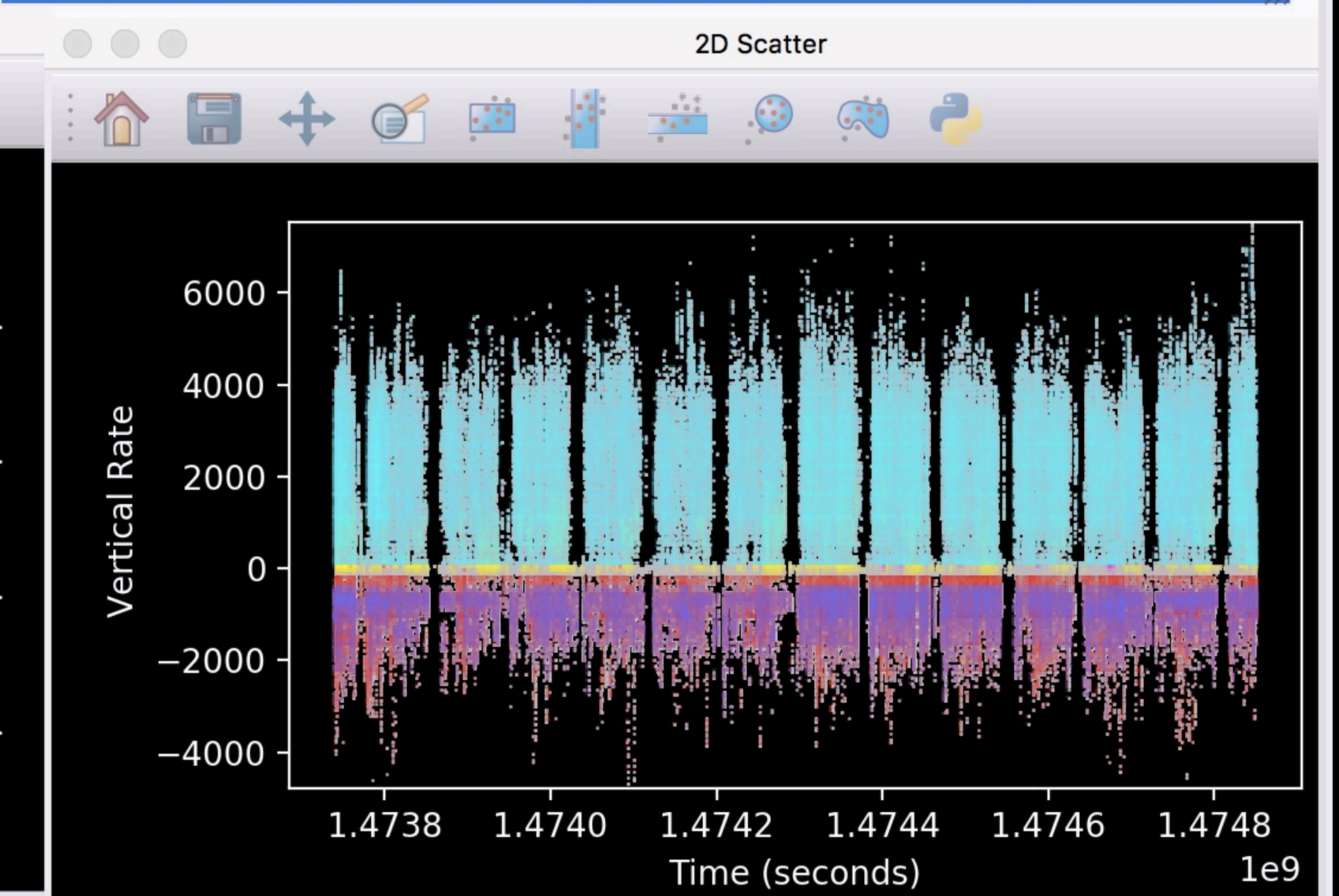
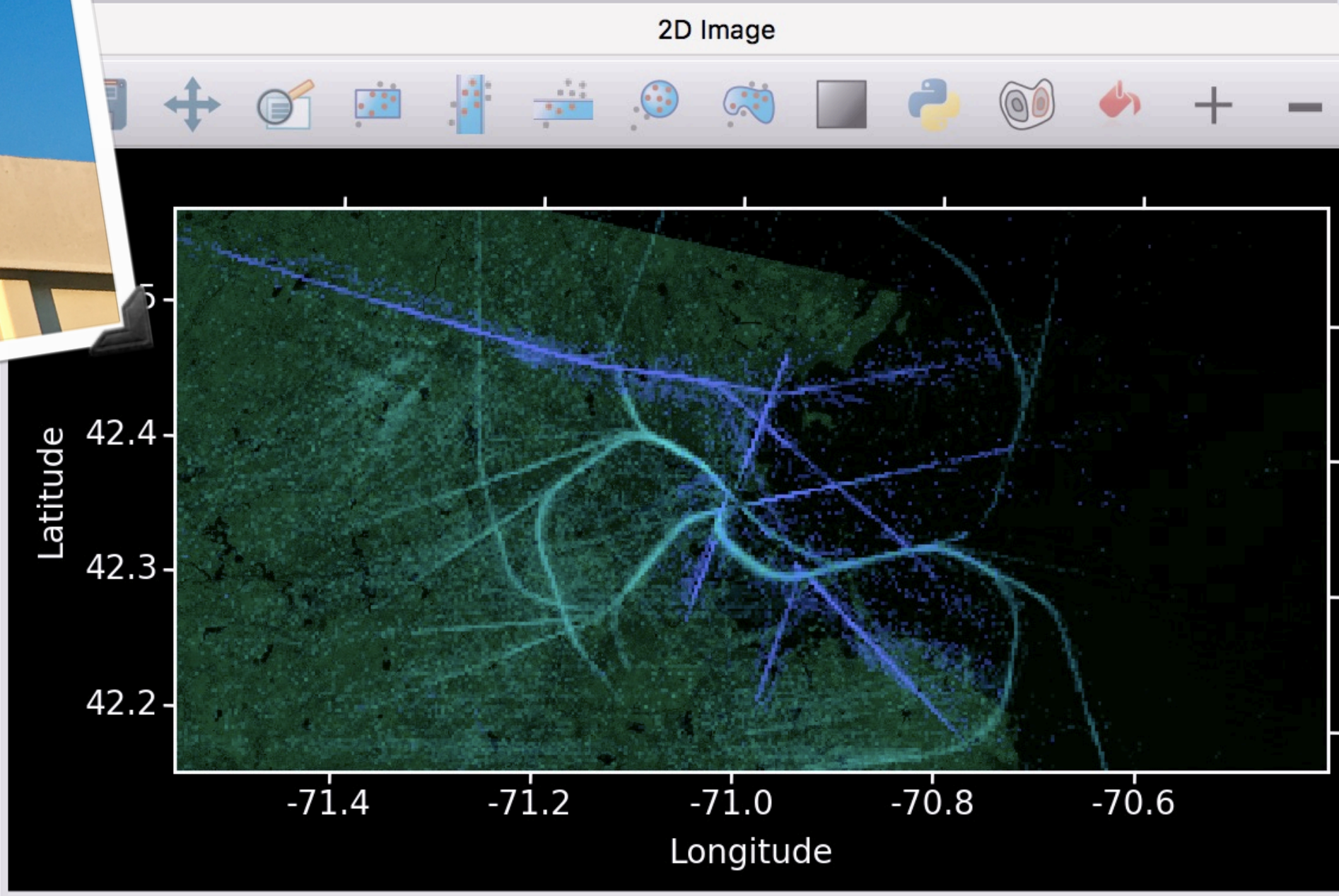
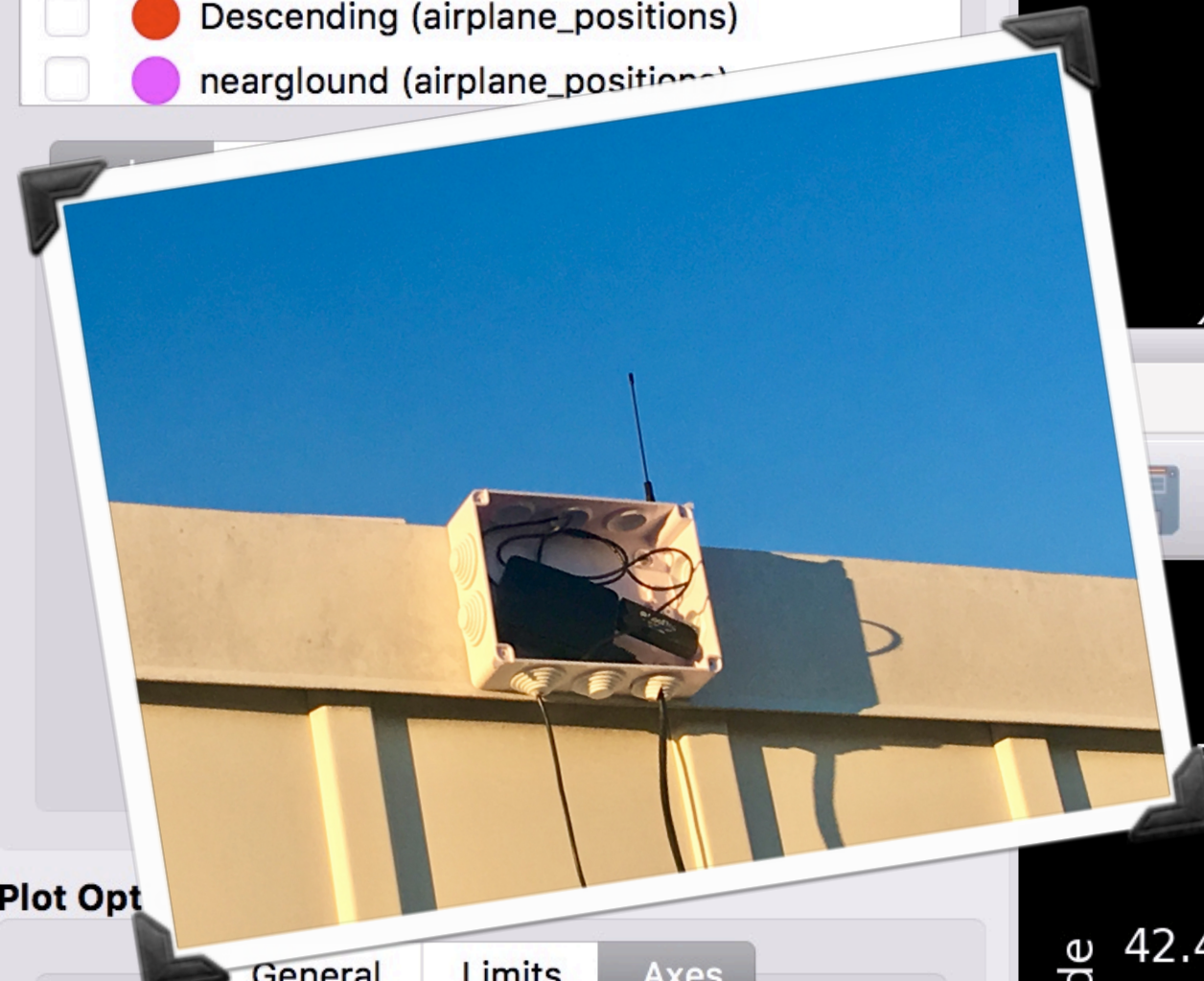
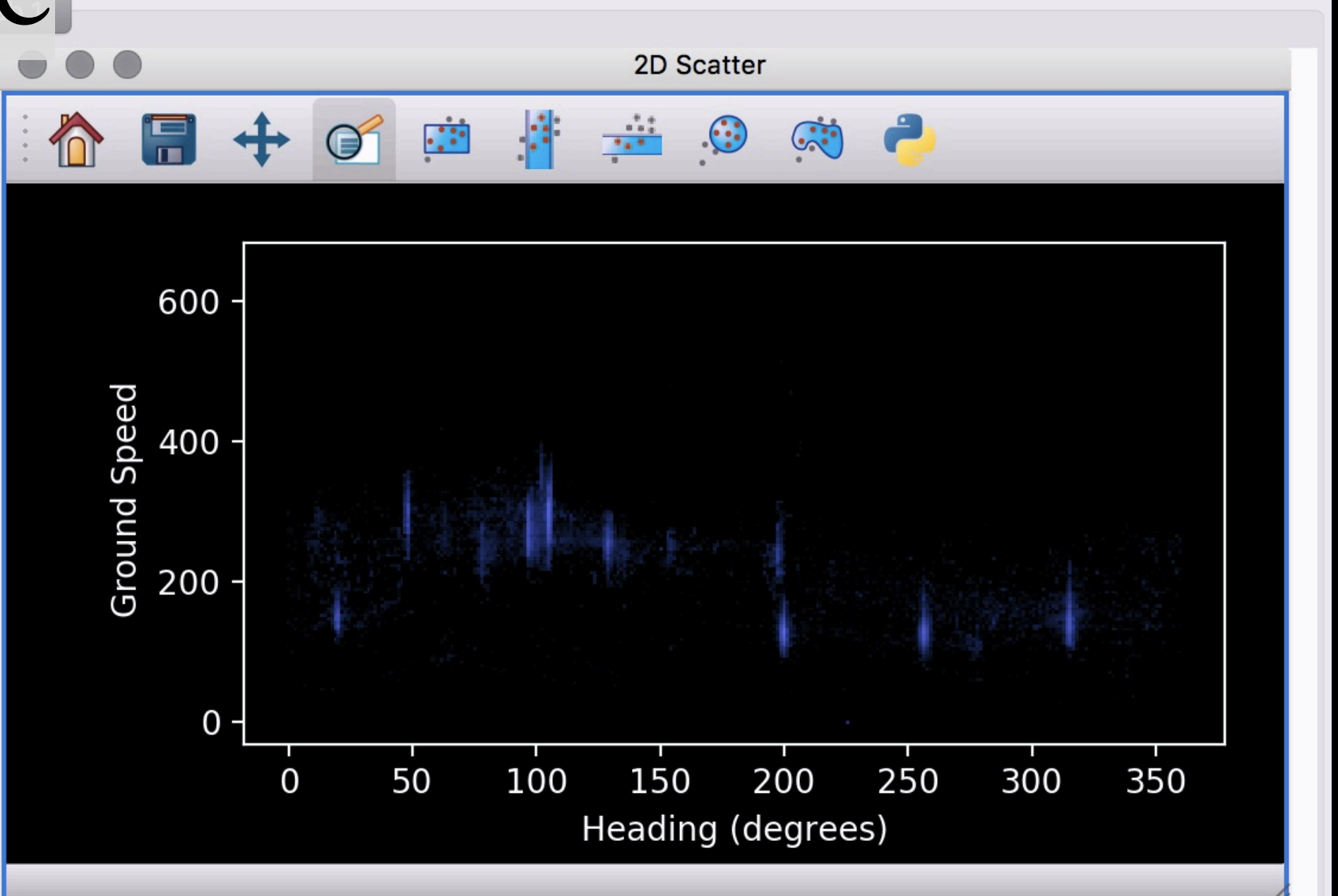
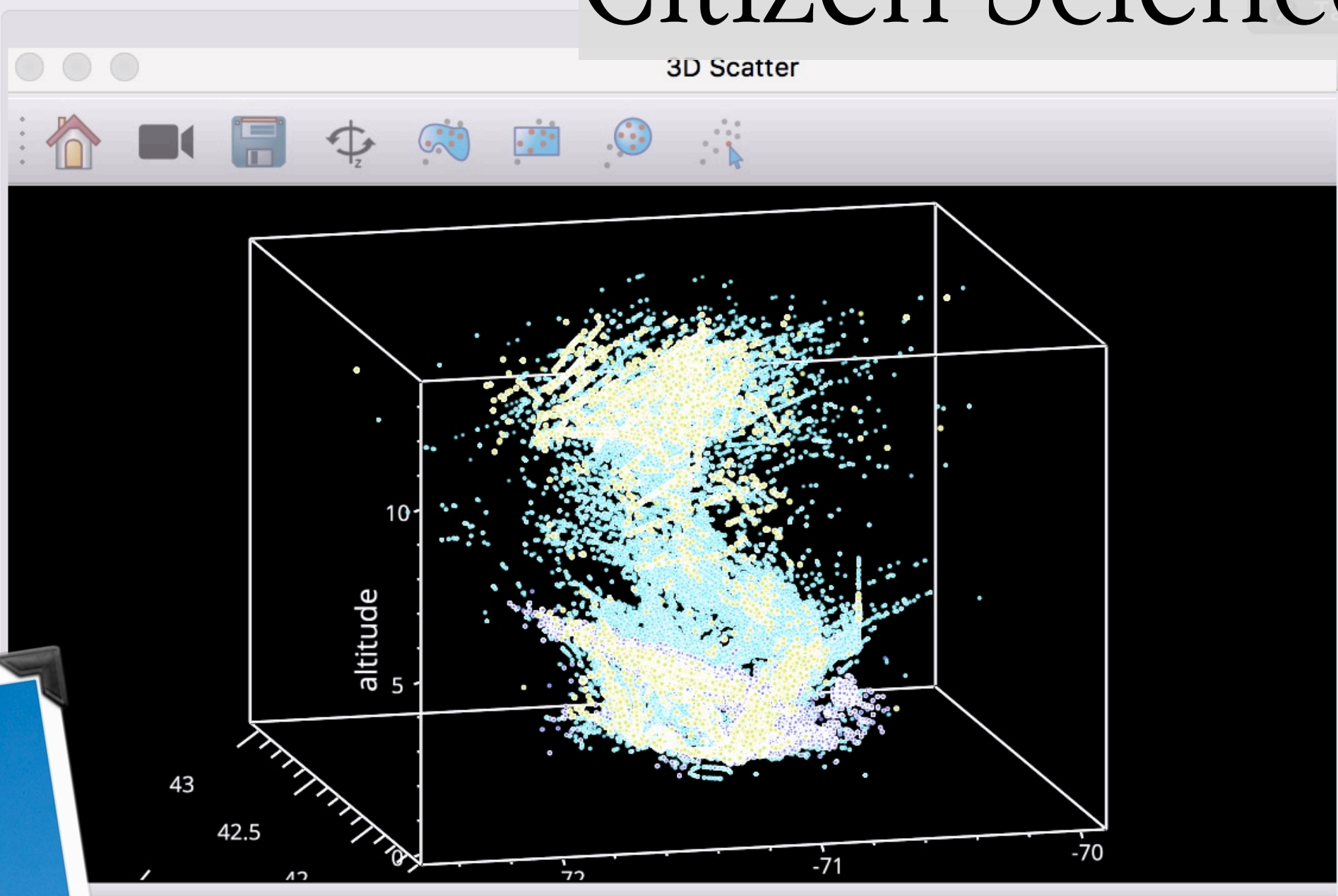
Citizen Science

Data Collection

- satelliteimages
- Subsets**
- fastplanes
- nearground
- Descending
- Climbing
- Landing
- A Day in the Life of Logan

Plot Layers - 2D Scatter

- A Day in the Life of Logan (airplane_positions)
- Landing (airplane_positions)
- Climbing (airplane_positions)
- Descending (airplane_positions)
- nearground (airplane_positions)



Plot Opt

General Limits Axes

x label: Heading (degrees)

y label: Ground Speed

axis label size: 10

axis label weight: medium

tick label size: 10

Apply to all plots

New Ideas
Discoveries

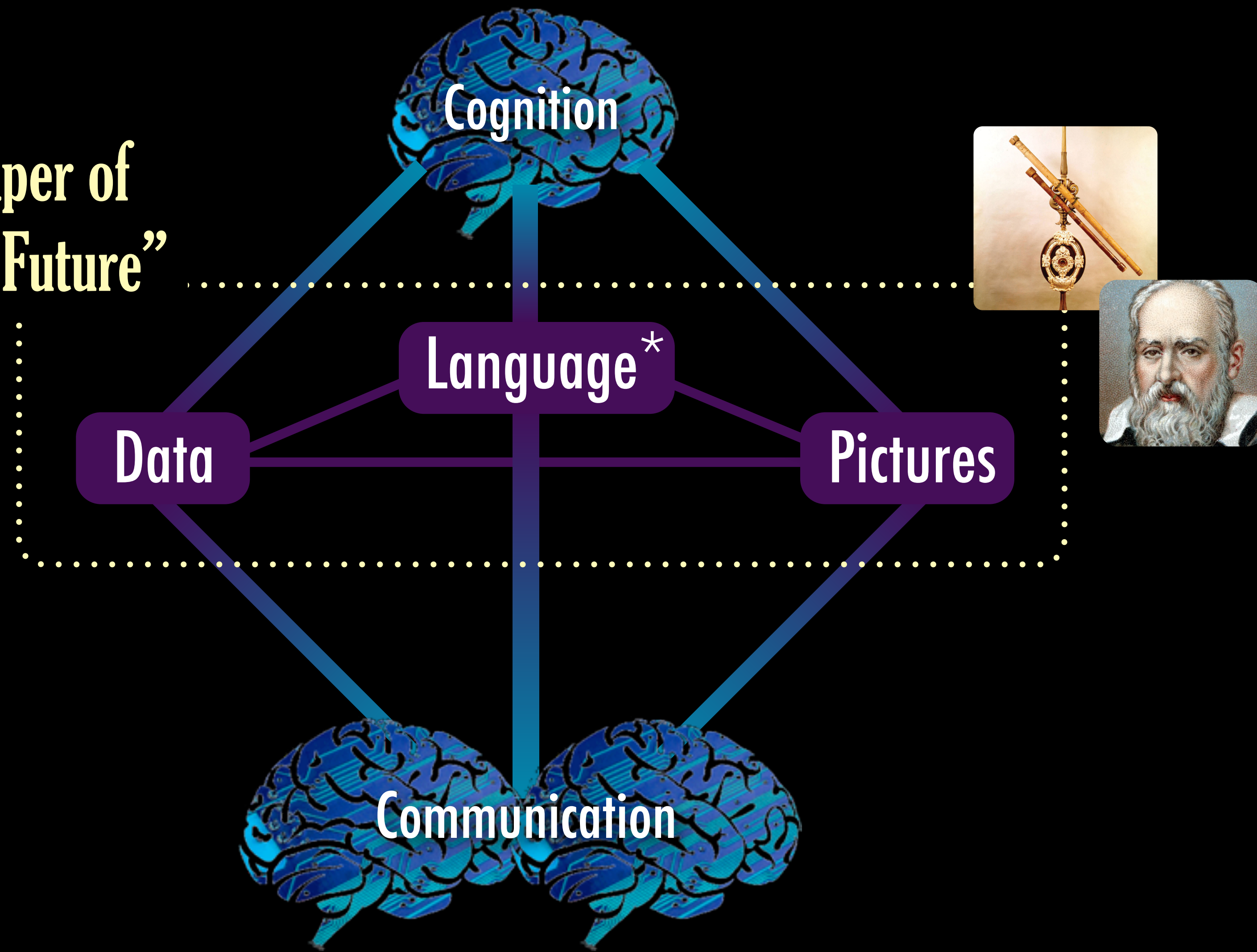
Public Outreach
Scholarly Publishing

Explore

Explain

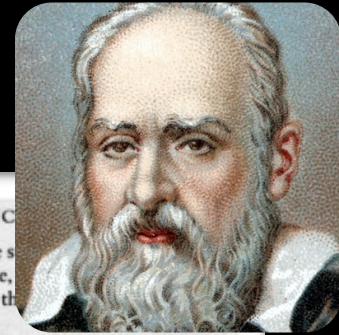
“It’s much harder to go the other way.”

“Paper of
the Future”



*"Language" includes words & math

1610



SIDEREUS NUNCIVS

On the third, at the seventh hour, the sequence. The eastern one was 1 minute, the closest western one 2 minutes; and the

East * ○ * West

10 minutes removed from this one. They were absolutely on the same straight line and of equal magnitude.

On the fourth, at the second hour, there were four stars around Jupiter, two to the east and two to the west, and arranged precisely

East * ○ * West

on a straight line, as in the adjoining figure. The easternmost was distant 3 minutes from the next one, while this one was 40 seconds from Jupiter; Jupiter was 4 minutes from the nearest western one, and this one 6 minutes from the westernmost one. Their magnitudes were nearly equal; the one closest to Jupiter appeared a little smaller than the rest. But at the seventh hour the eastern star was 30 seconds apart. Jupiter was 2 minutes from the

East ** ○ **

one, while he was 4 minutes from the next western one was 3 minutes from the westernmost one. They extended on the same straight line along the ecliptic.

On the fifth, the sky was cloudy.

On the sixth, only two stars appeared flanking Jupiter

East * ○ *

in the adjoining figure. The eastern one was 2 minutes from the western one 3 minutes from Jupiter. They were on the same straight line with Jupiter and equal in magnitude.

On the seventh, two stars stood near Jupiter, both arranged in this manner.

4 Centuries from Galileo to Galileo

1665



1895

ASTROPHYSICAL JOURNAL

AN INTERNATIONAL REVIEW OF SPECTROSCOPY AND ASTRONOMICAL PHYSICS

VOLUME I JANUARY 1895 NUMBER 1

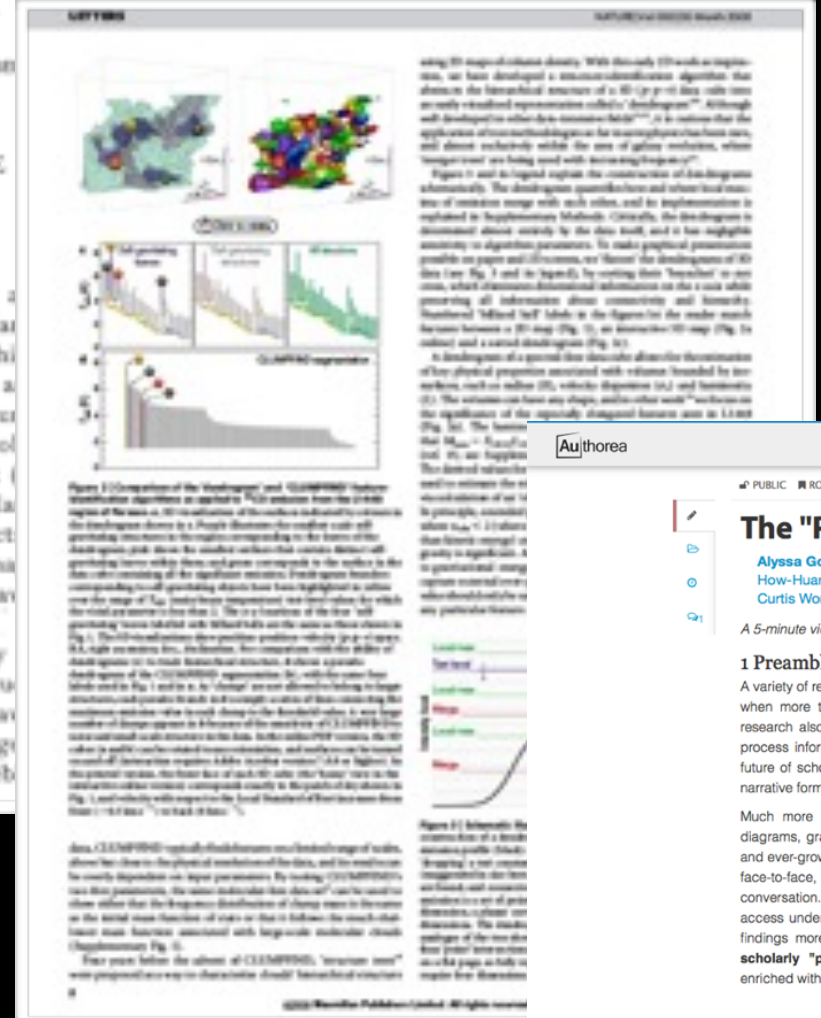
ON THE CONDITIONS WHICH AFFECT THE SPECTRO-PHOTOGRAPHY OF THE SUN.

By ALBERT A. MICHELSON.

The recent developments in solar spectro-photography are in great measure due to the device originally suggested by Janssen and perfected by Hale and Deslandres, by means of which a photograph of the Sun's prominences may be obtained at a time as readily as it is during an eclipse. The essential feature of this device are the simultaneous movements of the collimator-slit across the Sun's image, with that of a second slit (the focus of the photographic lens) over a photographic plate. If these relative motions are so adjusted that the same spectral line always falls on the second slit, then a photographic image of the Sun will be reproduced by light of this particular wavelength.

Evidently the process is not limited to the photography of the prominences, but extends to all other peculiarities of structure which emit radiations of approximately constant wavelength; and the efficiency of the method depends very largely upon the contrast which can be obtained by the greater exte-

2009



2015

Autorea

FEATURED ARTICLES ABOUT PLANS BLOG FEEDBACK HELP ALYSSA GOODMAN

Public ROUGH DRAFT

Index Settings Fork Quickedit Word Count 42 Comments Export Unfollow

The "Paper" of the Future

Alyssa Goodman, Josh Peek, Alberto Acomazzi, Chris Beaumont, Christine L. Borgman, How-Huan Hope Chen, Mercè Crosas, Christopher Erdmann, August Muench, Alberto Pepe, Curtis Wong

A 5-minute video demonstration of this paper is available at this YouTube link.

1 Preamble

A variety of research on human cognition demonstrates that humans learn and communicate best when more than one processing system (e.g. visual, auditory, touch) is used. And, related research also shows that, no matter how technical the material, most humans also retain and process information best when they can put a narrative "story" to it. So, when considering the future of scholarly communication, we should be careful not to do blindly away with the linear narrative format that articles and books have followed for centuries; instead, we should enrich it.

Much more than text is used to communicate in Science. Figures, which include images, diagrams, graphs, charts, and more, have enriched scholarly articles since the time of Galileo, and ever-growing volumes of data underpin most scientific papers. When scientists communicate face-to-face, as in talks or small discussions, these figures are often the focus of the conversation. In the best discussions, scientists have the ability to manipulate the figures, and to access underlying data, in real-time, so as to test out various what-if scenarios, and to explain findings more clearly. This short article explains—and shows with demonstrations—how scholarly "papers" can morph into long-lasting rich records of scientific discourse, enriched with deep data and code linkages, interactive figures, audio, video, and commenting.

Paper of the Future

Cognition

Galileo Discovers Jupiter's Moons, 1610

Sex^{mo} Principe.

Galileo Galilei, Familiari^o Seruo della Ser.^a V.^a inuigilanti.
 Do amittuano, et de ogni spicio se potere no solam satisfare
 aliaris che non della letura di Mathematici nelle sue
 Dio di Padova,

Truere Deuere determinato di presentare al Sex^{mo} Principe
 l'occhio et a p^{re}ssore di giuamenti inestimabile p^{er} ogni
 negozio et in irea marittima o terrestre stimo di tenere quel
 che nuovo artificio ne l' maggior segrete et uolage a disposizione
 di V.^a Ser.^a L'occhio auato dalle piu uolite speculazioni di
 prospectua in l' uantaggio di scoprire Legni et Vele dell' inimici
 Et ac hore et piu di tempo prima di egli susopra noi et distinguendo
 il numero et la qualita dei vasselli giudicare le sue forze
 pallescori alla caccia al ambasciamento o alla fuga, o pure auato
 nella campagna aperta uedere et particularm^{te} distinguere ogni sud
 iusto et propriamento.

Offe 7. di gennaio
 Giove si uede a 7^o * * * * *

Offe 8. di
 Giove si uede a 8^o * * * * *

Offe 12. di
 Giove si uede a 12^o * * * * *

Offe 13. di
 Giove si uede a 13^o * * * * *

Offe 14. di
 Giove si uede a 14^o * * * * *

Offe 15. di
 Giove si uede a 15^o * * * * *

Offe 16. di
 Giove si uede a 16^o * * * * *

Offe 17. di
 Giove si uede a 17^o * * * * *

Offe 18. di
 Giove si uede a 18^o * * * * *

Offe 19. di
 Giove si uede a 19^o * * * * *

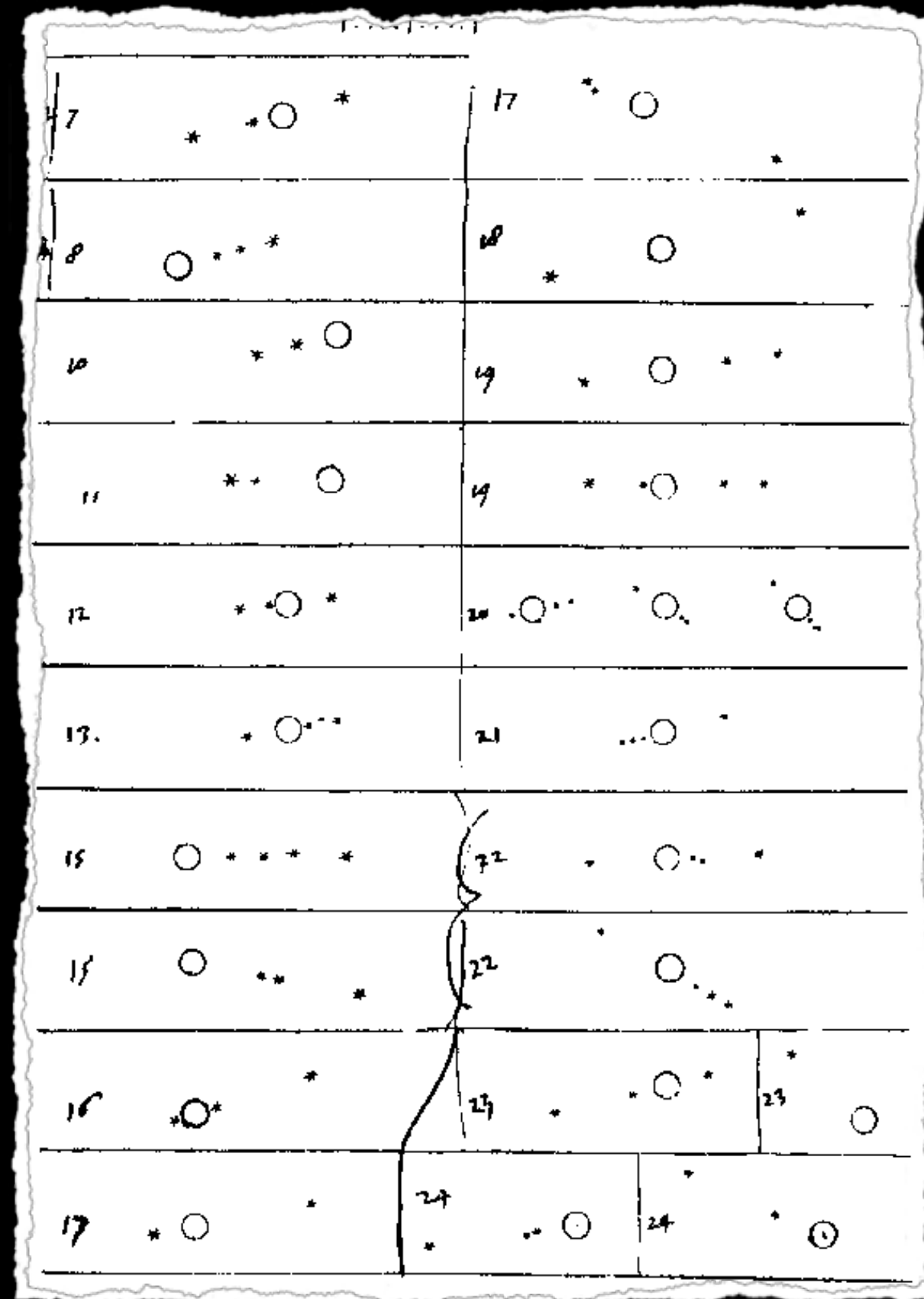
Offe 20. di
 Giove si uede a 20^o * * * * *

Offe 21. di
 Giove si uede a 21^o * * * * *

Offe 22. di
 Giove si uede a 22^o * * * * *

Offe 23. di
 Giove si uede a 23^o * * * * *

Offe 24. di
 Giove si uede a 24^o * * * * *



SIDEREOS NUNCIUS

On the third, at the seventh hour, the stars were arranged in this
 sequence. The eastern one was 1 minute, 30 seconds from Jupiter,
 the closest western one 2 minutes; and the other western one was
 3 minutes removed from this one. They were absolutely on the
 same straight line and of equal magnitude.

On the fourth, at the second hour, there were four stars around
 Jupiter, two to the east and two to the west, and arranged precisely
 on a straight line, as in the adjoining figure. The easternmost was
 distant 3 minutes from the next one, while this one was 40 seconds
 from Jupiter; Jupiter was 4 minutes from the nearest western one,
 and this one 6 minutes from the westernmost one. Their magnitudes
 were nearly equal; the one closest to Jupiter appeared a little smaller
 than the rest. But at the seventh hour the eastern stars were only
 20 seconds apart. Jupiter was 2 minutes from the nearer eastern
 one, while he was 4 minutes from the next western one, and this
 one was 3 minutes from the westernmost one. They were all equal
 and extended on the same straight line along the ecliptic.

On the fifth, the sky was cloudy.

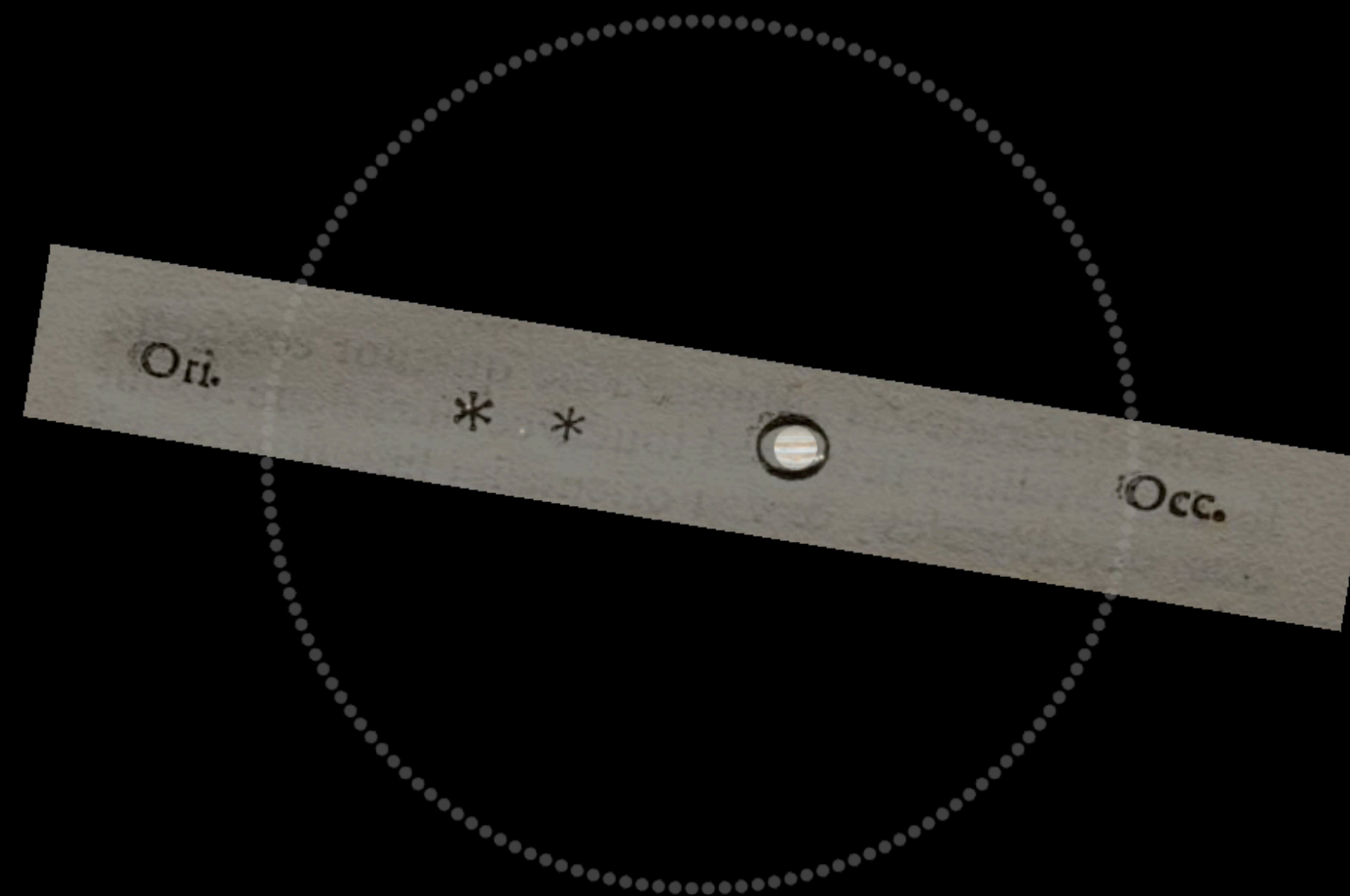
On the sixth, only two stars appeared flanking Jupiter, as is seen
 in the adjoining figure. The eastern one was 2 minutes and the
 western one 3 minutes from Jupiter. They were on the same straight
 line with Jupiter and equal in magnitude.

On the seventh, two stars stood near Jupiter, both to the east,



January 11, 1610

1610



2015



The "Paper" of the Future

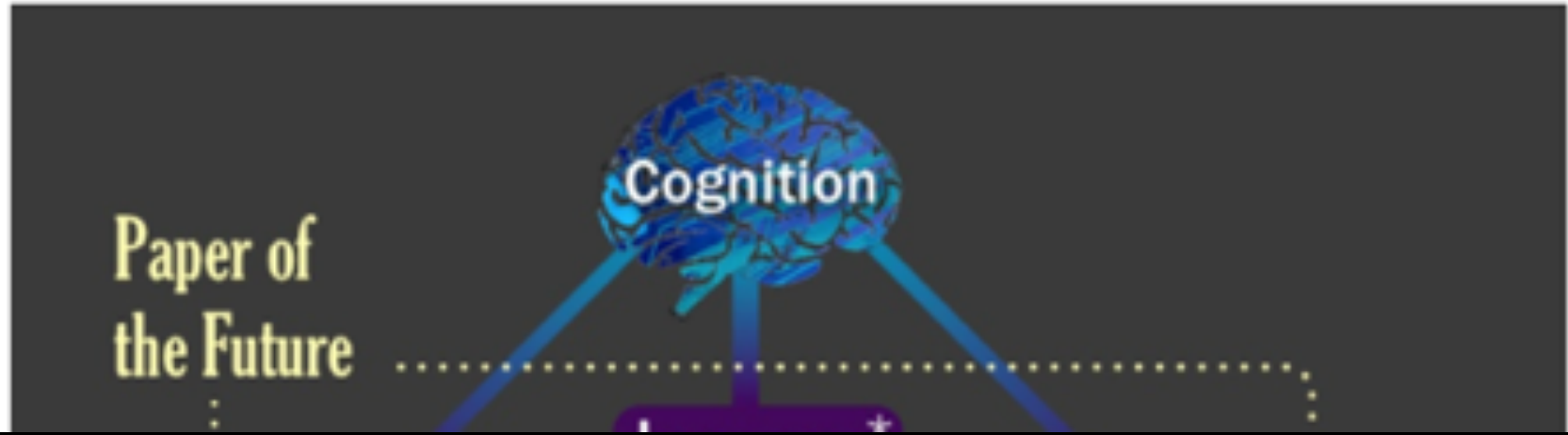
Alyssa Goodman, Josh Peek, Alberto Accomazzi, Chris Beaumont, Christine L. Borgman, How-Huan Hope Chen, Merce Crosas, Christopher Erdmann, August Muench, Alberto Pepe, Curtis Wong

A 5-minute video demonstration of this paper is available at [this YouTube link](#).

1 Preamble

A variety of research on human cognition demonstrates that humans learn and communicate best when more than one processing system (e.g. visual, auditory, touch) is used. And, related research also shows that, no matter how technical the material, most humans also retain and process information best when they can put a narrative "story" to it. So, when considering the future of scholarly communication, we should be careful not to do blithely away with the linear narrative format that articles and books have followed for centuries: instead, we should enrich it.

Much more than text is used to communicate in Science. Figures, which include images, diagrams, graphs, charts, and more, have enriched scholarly articles since the time of Galileo, and ever-growing volumes of data underpin most scientific papers. When scientists communicate face-to-face, as in talks or small discussions, these figures are often the focus of the conversation. In the best discussions, scientists have the ability to manipulate the figures, and to access underlying data, in real-time, so as to test out various what-if scenarios, and to explain findings more clearly. **This short article explains—and shows with demonstrations—how scholarly "papers" can morph into long-lasting rich records of scientific discourse, enriched with deep data and code linkages, interactive figures, audio, video, and commenting.**



3

Konrad Hinsien 3 days ago · Public
Many good suggestions, but if the goal is "long-lasting rich records of scientific discourse", a more careful and critical attitude towards electronic artifacts is appropriate. I do see it concerning videos, but not a word on the much more critical situation in software. Archiving source code is not sufficient: all the dependencies, plus the complete build environment, would have to be conserved as well to make things work a few years from now. An "executable figure" in the form of an IPython notebook will...
[more](#)

2

Merce Crosas 3 days ago · Public
Konrad, good points; this has been a concern for the community working on reproducibility. Regarding data repositories, Dataverse handles long-term preservation and access of data files in the following way: 1) for some data files that the repository recognizes (such as R Data, SPSS, STATA), which depend on a statistical package, the system converts them into a preservation format (such as a tab/CSV format). Even though the original format is also saved and can be accessed, the new preservation format gua...
[more](#)

0

Konrad Hinsien 1 day ago · Public
That sounds good. I hope more repositories will follow the example of Dataverse. Figshare in particular has a very different attitude, encouraging researchers to deposit as much as possible. That's perhaps a good strategy to change habits, but in the long run it could well backfire when people find out in a few years that 90% of those deposits have become useless.

Christine L. Borgman 4 months ago · Private
"publications"

[demo]

2009

3D PDF
interactivity
in a "Paper"

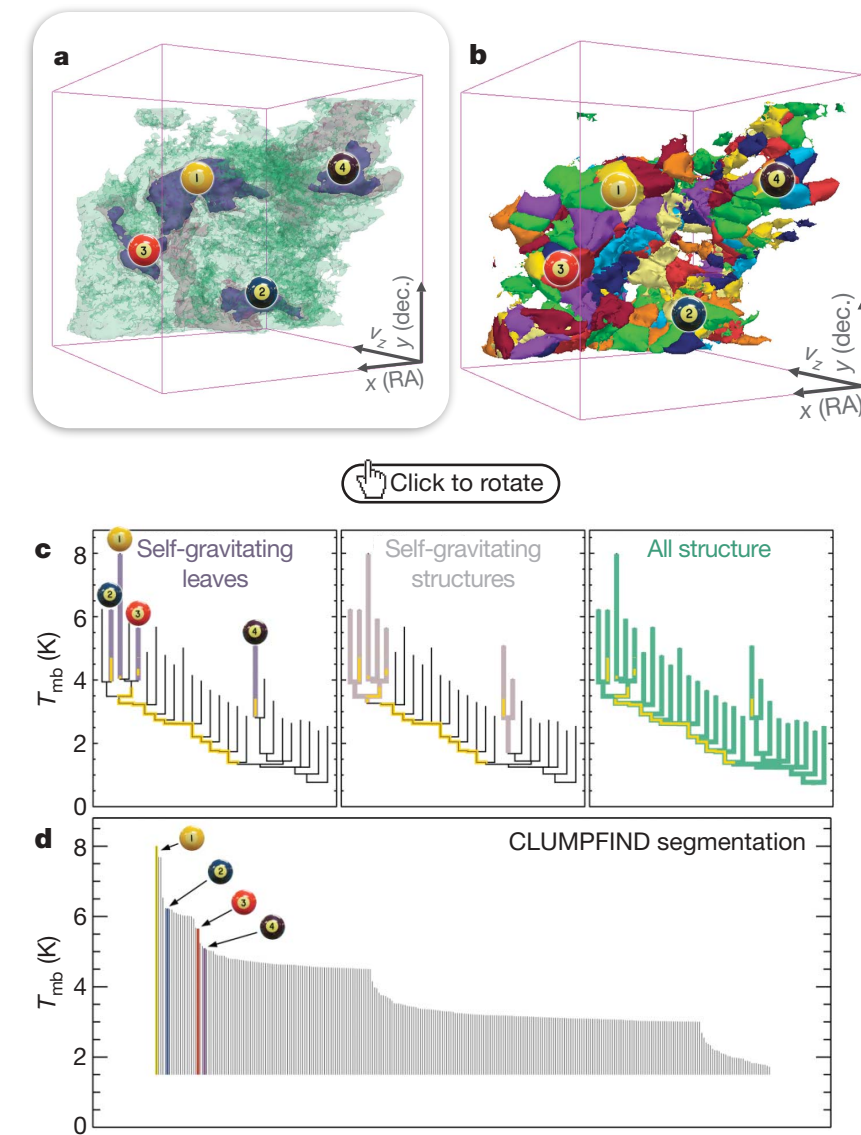


Figure 2 | Comparison of the 'dendrogram' and 'CLUMPFIND' feature-identification algorithms as applied to ¹³CO emission from the L1448 region of Perseus. **a**, 3D visualization of the surfaces indicated by colours in the dendrogram shown in **c**. Purple illustrates the smallest scale self-gravitating structures in the region corresponding to the leaves of the dendrogram; pink shows the smallest surfaces that contain distinct self-gravitating leaves within them; and green corresponds to the surface in the data cube containing all the significant emission. Dendrogram branches corresponding to self-gravitating objects have been highlighted in yellow over the range of T_{mb} (main-beam temperature) test-level values for which the virial parameter is less than 2. The x - y locations of the four 'self-gravitating' leaves labelled with billiard balls are the same as those shown in Fig. 1. The 3D visualizations show position-position-velocity (p - p - v) space. RA, right ascension; dec., declination. For comparison with the ability of dendrograms (**c**) to track hierarchical structure, **d** shows a pseudo-dendrogram of the CLUMPFIND segmentation (**b**), with the same four labels used in Fig. 1 and in **a**. As 'clumps' are not allowed to belong to larger structures, each pseudo-branch in **d** is simply a series of lines connecting the maximum emission value in each clump to the threshold value. A very large number of clumps appears in **b** because of the sensitivity of CLUMPFIND to noise and small-scale structure in the data. In the online PDF version, the 3D cubes (**a** and **b**) can be rotated to any orientation, and surfaces can be turned on and off (interaction requires Adobe Acrobat version 7.0.8 or higher). In the printed version, the front face of each 3D cube (the 'home' view in the interactive online version) corresponds exactly to the patch of sky shown in Fig. 1, and velocity with respect to the Local Standard of Rest increases from front (-0.5 km s^{-1}) to back (8 km s^{-1}).

data, CLUMPFIND typically finds features on a limited range of scales, above but close to the physical resolution of the data, and its results can be overly dependent on input parameters. By tuning CLUMPFIND's two free parameters, the same molecular-line data set⁸ can be used to show either that the frequency distribution of clump mass is the same as the initial mass function of stars or that it follows the much shallower mass function associated with large-scale molecular clouds (Supplementary Fig. 1).

Four years before the advent of CLUMPFIND, 'structure trees'⁹ were proposed as a way to characterize clouds' hierarchical structure

using 2D maps of column density. With the early 2D work as inspiration, we have developed a structure-identifying algorithm that abstracts the hierarchical structure of a data cube into an easily visualized representation called a dendrogram, well developed in other data-intensive fields. The application of tree methodologies so far has been almost exclusively within the astronomical domain, and 'merger trees' are being used with increasing frequency.

Figure 3 and its legend explain the dendrogram process schematically. The dendrogram quality is determined almost entirely by the sensitivity to algorithm parameters, which can be varied as possible on paper and 2D screen (see Fig. 3 and its legend for details). The dendrogram cross, which eliminates dimensions, preserves all information about the structure. Numbered 'billiard ball' labels track features between a 2D map (see Fig. 3 and its legend online) and a sorted dendrogram.

A dendrogram of a spectral cube tracks the evolution of key physical properties of features, such as radius (R), luminosity (L), and virial parameter (α). The volumes can have any shape, and the significance of the especially elongated features is highlighted (Fig. 2a). The luminosity is an approximate proxy for mass, such that $M_{lum} = X_{13CO} L_{13CO}$, where $X_{13CO} = 8.0 \times 10^{20} \text{ cm}^{-2} \text{ K}^{-1} \text{ s}$ (ref. 15; see Supplementary Methods and Supplementary Fig. 2). The derived values for size, mass and velocity dispersion can then be used to estimate the role of self-gravity at each point in the hierarchy, via calculation of an 'observed' virial parameter, $\alpha_{obs} = 5\sigma_v^2 R/GM_{lum}$. In principle, extended portions of the tree (Fig. 2, yellow highlighting) where $\alpha_{obs} < 2$ (where gravitational energy is comparable to or larger than kinetic energy) correspond to regions of p - p - v space where self-gravity is significant. As α_{obs} only represents the ratio of kinetic energy to gravitational energy at one point in time, and does not explicitly capture external over-pressure and/or magnetic fields¹⁶, its measured value should only be used as a guide to the longevity (boundedness) of any particular feature.

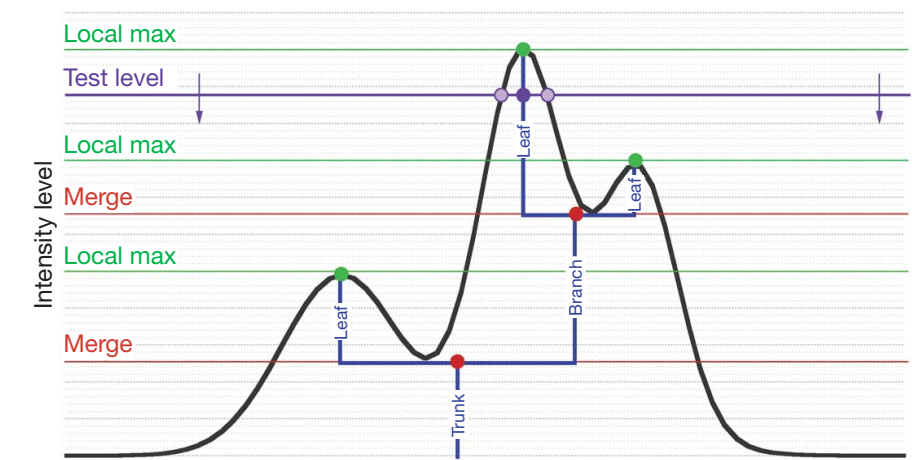
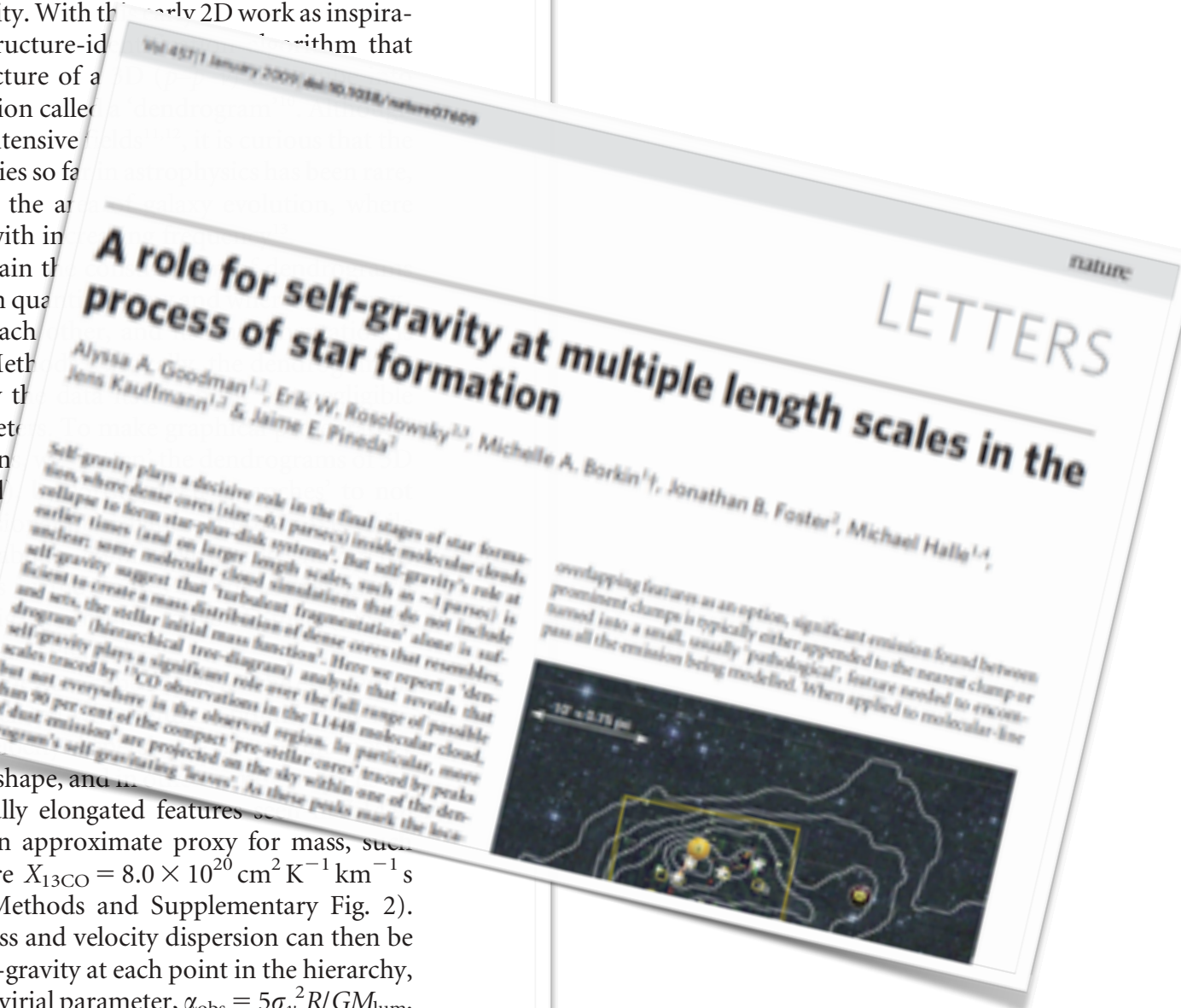


Figure 3 | Schematic illustration of the dendrogram process. Shown is the construction of a dendrogram from a hypothetical one-dimensional emission profile (black). The dendrogram (blue) can be constructed by 'dropping' a test constant emission level (purple) from above in tiny steps (exaggerated in size here, light lines) until all the local maxima and mergers are found, and connected as shown. The intersection of a test level with the emission is a set of points (for example the light purple dots) in one dimension, a planar curve in two dimensions, and an isosurface in three dimensions. The dendrogram of 3D data shown in Fig. 2c is the direct analogue of the tree shown here, only constructed from 'isosurface' rather than 'point' intersections. It has been sorted and flattened for representation on a flat page, as fully representing dendrograms for 3D data cubes would require four dimensions.



Goodman et al. 2009, Nature,
cf: Fluke et al. 2009

1 / 4 131% Tools Comment Share

Vol 457|1 January 2009|doi:10.1038/nature07609 nature

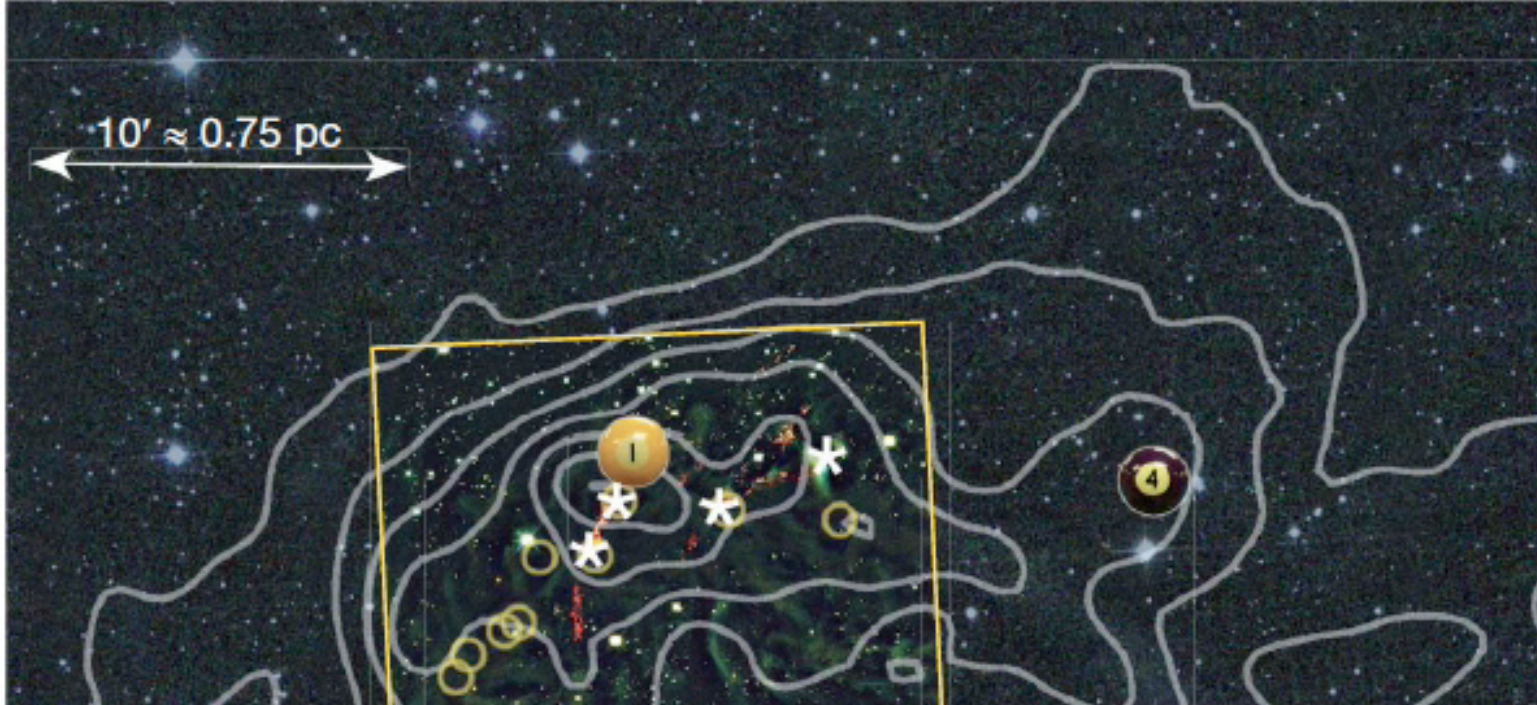
LETTERS

A role for self-gravity at multiple length scales in the process of star formation

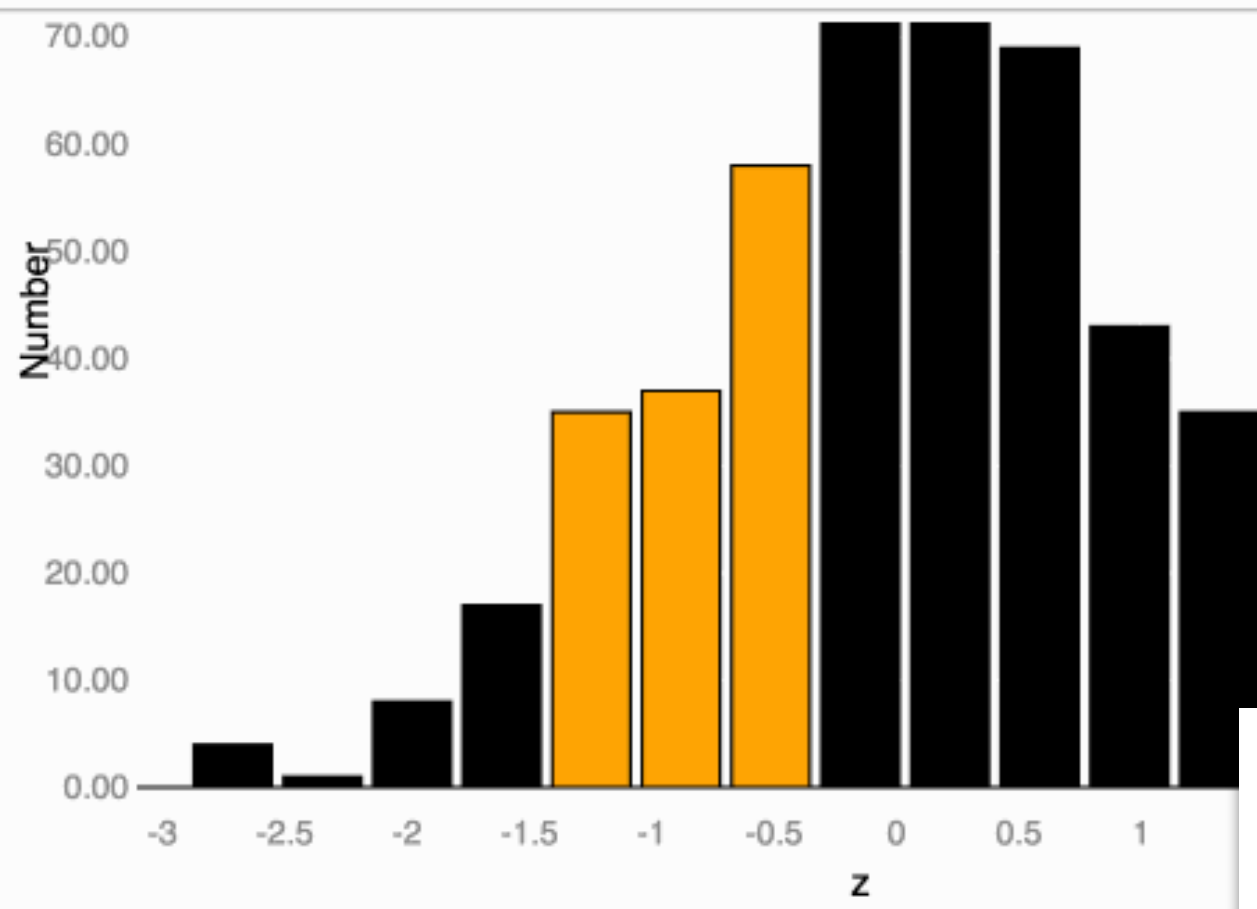
Alyssa A. Goodman^{1,2}, Erik W. Rosolowsky^{2,3}, Michelle A. Borkin^{1†}, Jonathan B. Foster², Michael Halle^{1,4}, Jens Kauffmann^{1,2} & Jaime E. Pineda²

Self-gravity plays a decisive role in the final stages of star formation, where dense cores (size ~ 0.1 parsecs) inside molecular clouds collapse to form star-plus-disk systems¹. But self-gravity's role at earlier times (and on larger length scales, such as ~ 1 parsec) is unclear; some molecular cloud simulations that do not include self-gravity suggest that 'turbulent fragmentation' alone is sufficient to create a mass distribution of dense cores that resembles, and sets, the stellar initial mass function². Here we report a 'dendrogram' (hierarchical tree-diagram) analysis that reveals that self-gravity plays a significant role over the full range of possible scales traced by ¹³CO observations in the L1448 molecular cloud, but not everywhere in the observed region. In particular, more than 90 per cent of the compact 'pre-stellar cores' traced by peaks of dust emission³ are projected on the sky within one of the dendrogram's self-gravitating 'leaves'. As these peaks mark the locations of already-forming stars, or of those probably about to form, a self-gravitating cocoon seems a critical condition for their exist-

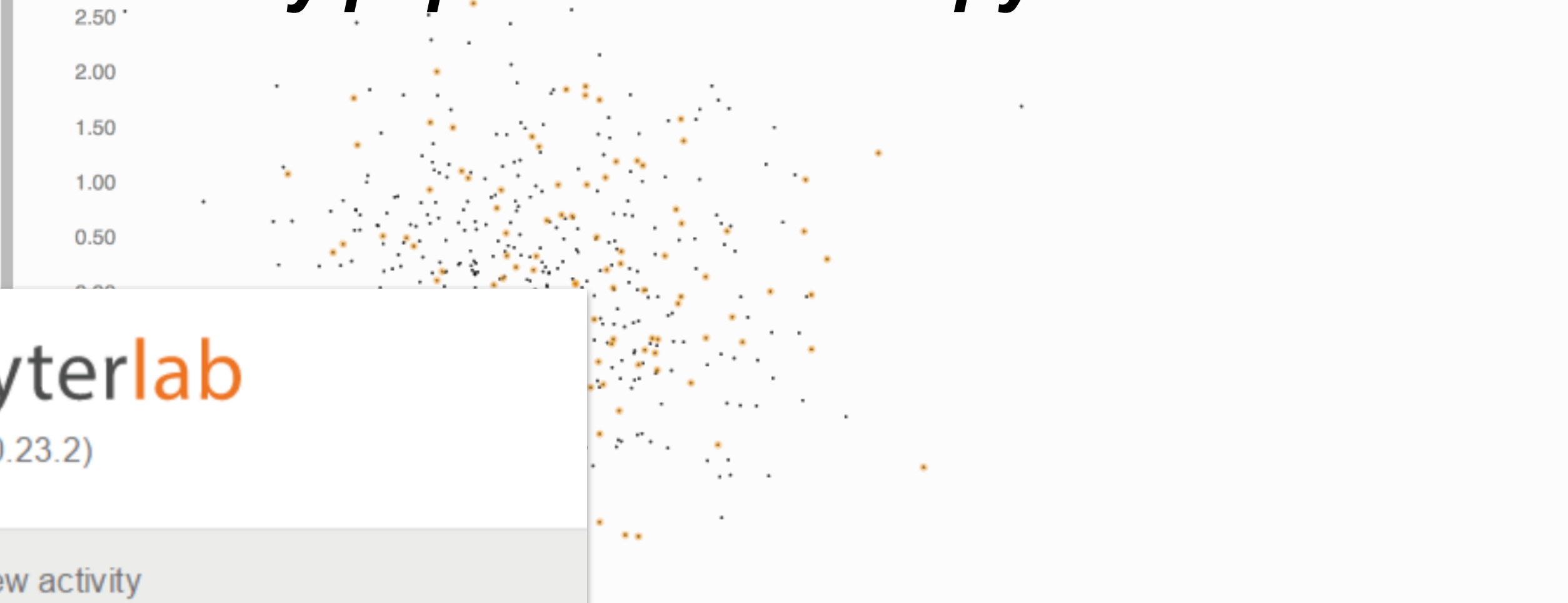
overlapping features as an option, significant emission found between prominent clumps is typically either appended to the nearest clump or turned into a small, usually 'pathological', feature needed to encompass all the emission being modelled. When applied to molecular-line



The image shows a dark field of stars with white contour lines overlaid, representing the dendrogram analysis of the L1448 molecular cloud. A yellow rectangular box highlights a specific region. A scale bar at the top left indicates a length of 10 arcminutes, which is approximately 0.75 parsecs. Several numbered circles (1, 2, 3, 4) are placed on the contours, likely marking specific features or cores of interest.



and scholarly papers with/in “Jupyter” notebooks



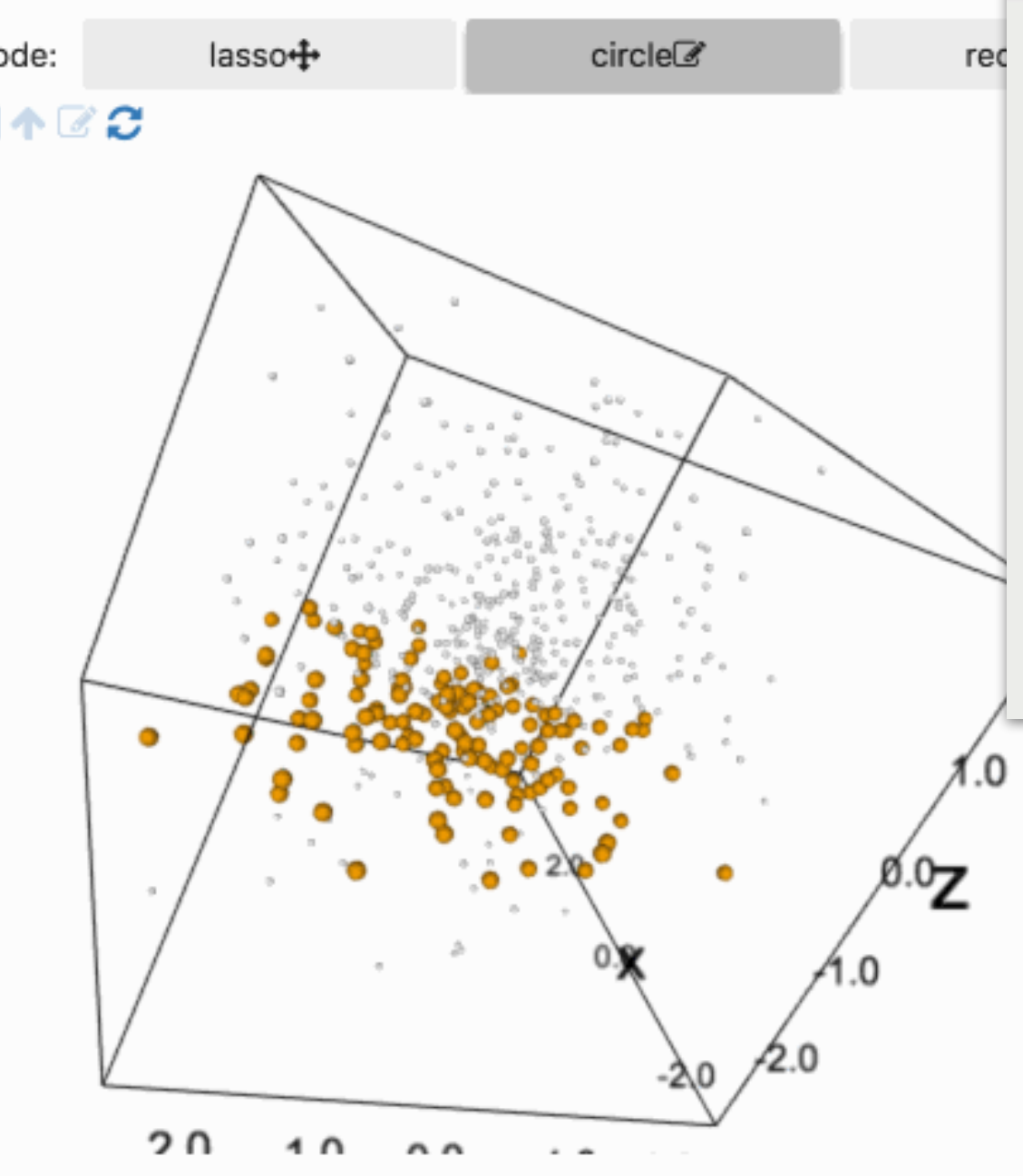
jupyterlab
alpha (v0.23.2)

Start a new activity

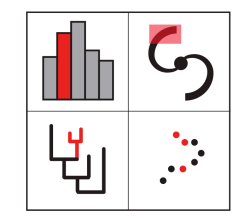
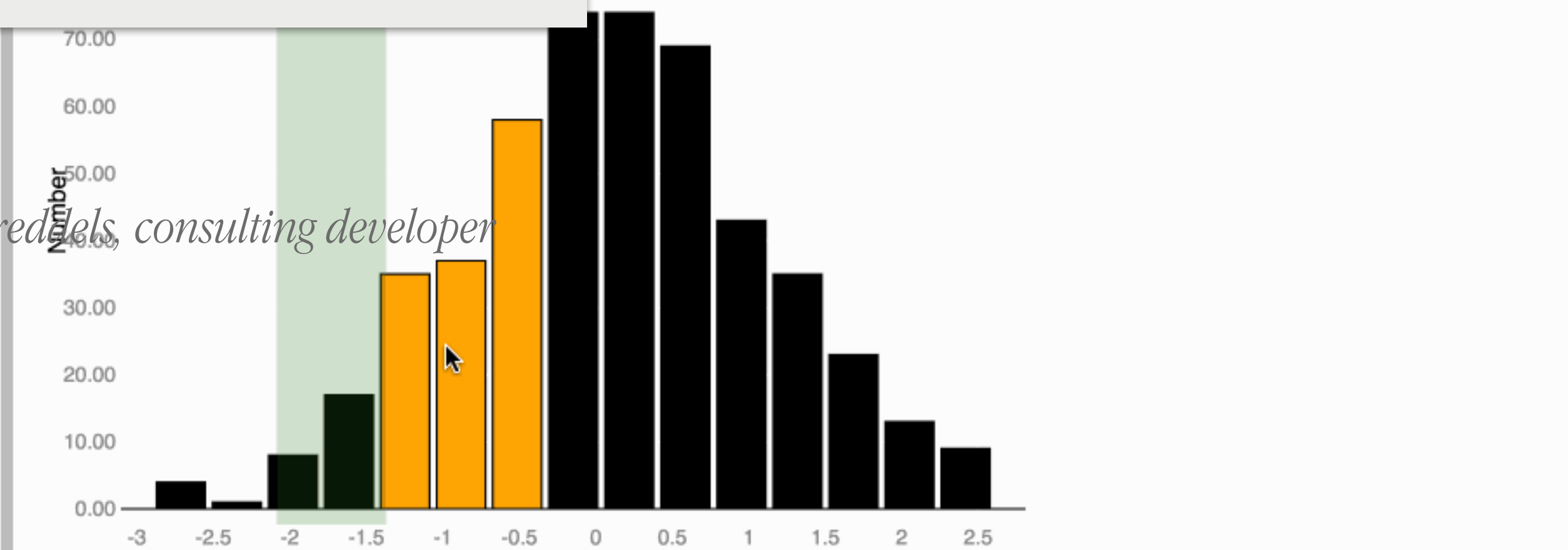
- Notebook
- Code Console
- Text Editor

2018

```
In [4]: app.scatter3d('x', 'y', 'z');
```



Video courtesy of Maarten Breddeles, consulting developer



Google Books Ngram Viewer

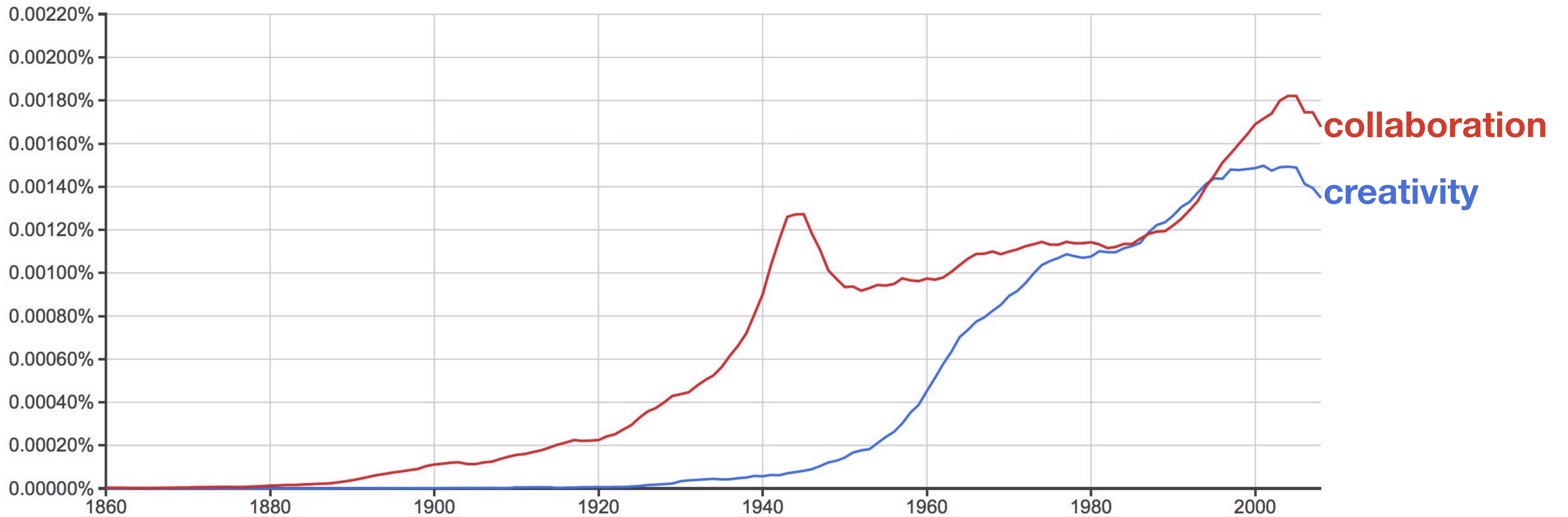
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agoodman

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This project is part of an ongoing NASA-funded effort aimed at turning the SAO/NASA Astrophysics Data System (ADS) into a data resource. The result will be a database of astro-referenced images, i.e., images of the sky for which coordinates, orientation, and pixel scale will be publicly available through NASA data archives, [the Astronomy Image Explorer](#), and [World Wide Telescope](#), thanks to your help!

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python File Edit View Canvas

Data Collection

Data

- hst_13485_04_wfc3_uvvis_f656n_drz[HDRT...]
- hst_13485_04_wfc3_uvvis_f656n_drz[CTX]

Subsets

- Subset 1

glue

Plot Layers - 1D Histogram

- Subset 1 (hst_13485_04_wfc3_uvvis_f656n_drz)
- hst_13485_04_wfc3_uvvis_f656n_drz[CTX]

color

opacity

Plot Options - 1D Histogram

General Limits Axes

x axis SCI log

bins 12855e-07 0.629327 18

Update bins to view

y axis normalized cumulative log

Fixed # of numerical bins

ROOTNAME	A_0_2	A_0
0 lc9a04cvq SCI 2 9.46198776525... 1.903870		
1 lc9a04cvq SCI 1 -1.0648009211... 2.360268		
2 lc9a04cvq SCI 1 9.46198776525... 1.903870		
3 lc9a04cvq SCI 2 -1.0648009211... 2.360268		
4 lc9a04d0q SCI 1 9.46198776525... 1.903870		
5 lc9a04d0q SCI 2 -1.0648009211... 2.360268		
6 lc9a04d4q SCI 1 9.46198776525... 1.903870		
7 lc9a04d4q SCI 2 -1.0648009211... 2.360268		

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Logos for VgTC, IEEE, and IEEE Computer Society.

Data Collection

Data

- L1448 Data
- L1448 Data

Subsets

Plot Layers - 3D Volume Rendering

- 1 (L1448 Data)
- L1448 Data

Attribute: intensity

Min: -0.66 Max: 16

Color:

Alpha:

Plot Options - 3D Volume Rendering

x axis

min 0 max: 105

stretch: 1.06

y axis

min 0 max: 105

stretch: 0.94

z axis

min 0 max: 53

stretch: 0.53

This repository

glue-viz / glue

Issues 273 Pull requests 16 Projects 1 Wiki Insights

Log axis labels in 1D histograms #1597

Open aagoodman opened this issue a minute ago · 0 comments

aagoodman commented a minute ago

The .glu file that can reproduce the behavior below is at <https://www.dropbox.com/sh/Op1wz6pax5gwjwAAC2J4Va88Vp75o6Dtkn6hna7d=0>.

What happens? When you make a histogram and ask for (both, or one) log axes, the tick labeling is not right, as shown below.

Miraculously, if you save the file as a .glu session, the situation improves somewhat. The same plot shown above opens with the x-axis labels fixed, but the y-axis labels no longer "log" and in fact just oddly wrong?

But, then, if you click to load off a few bins, the situation improves even more. The same plot shown above opens with the x-axis labels fixed, but the y-axis labels no longer "log" and in fact just oddly wrong?

Oddly, at some point of all the on/off clicking, they can also look like this.

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The Road from **Exploration** to **Explanation**, and Back



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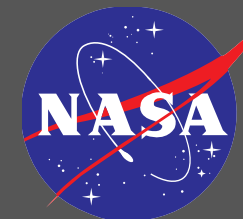
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Alyssa A. Goodman

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